Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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CONTENTS

EDITORIALS 1, 2

LEADING ARTICLES

Paying for Construction and Maintenance of Car Track Paving 3
The Engineer As a Professional Man 6
Highway Traffic Inspection Force Authorized in Pennsylvania 8
Some Recent Large Water Works Projects 9
For Those Who are Fond of Fine Old Writing 14
The Water Works Coal Pile 17
A Comparison of Flood Control Measures 22
Notes on Water Supply Service at Charleston, South Carolina 27
Practical Ranges in Load Factors for Water Purification Plants 33
Function of Streets and Highways in National Transportation 38
The Possibilities in Inland Waterway Development 40
The Truck as the Railroad's Ally 43
Painting Concrete Swimming Pools 46
Valuable Trade Literature 46

CONSTRUCTION NEWS AND EQUIPMENT SECTION

The Somervell Gasoline Hammer Drill 21
Carrying Service to the "Caterpillar" Owner and Operator 24

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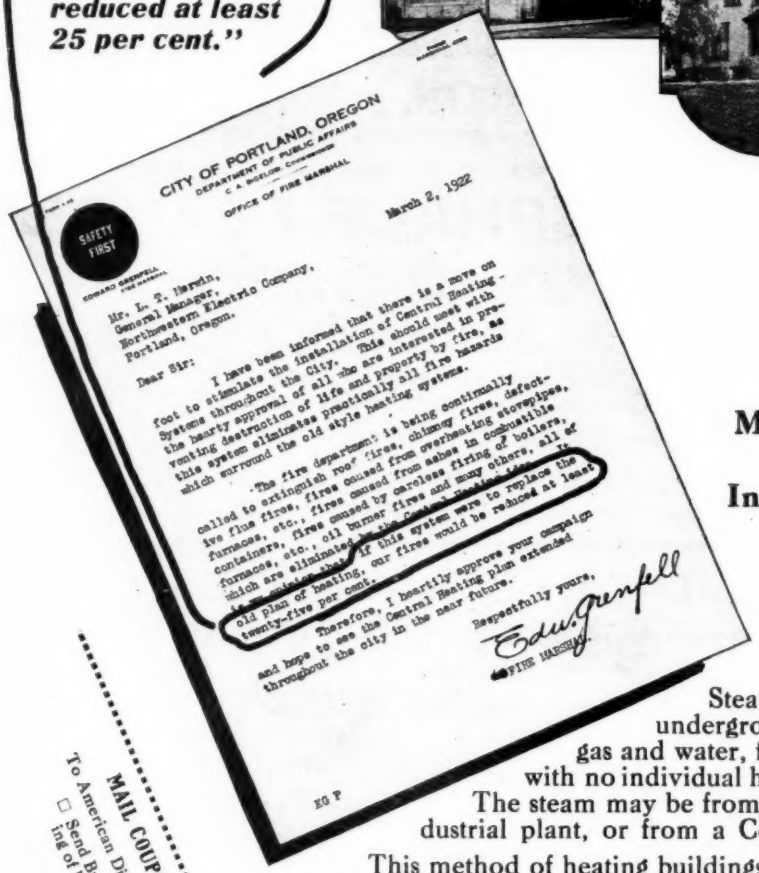

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DEPARTMENT OF PUBLIC AFFAIRS
C. A. BIGELOW, Commissioner
OFFICE OF FIRE MARSHAL

SAFETY FIRST
EDWARD GRENFELL, Fire Marshal

March 2, 1922

Mr. L. T. Erwin,
General Manager,
Northwestern Electric Company,
Portland, Oregon.

Dear Sir:

I have been informed that there is a move on foot to stimulate the City Systems throughout of all who the hearty approval of life and property by fire, venting destruction of this should meet with this system eliminates practically all fire hazards which surround the old style heating systems.

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Respectfully yours,
Edw. Grenfell
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EDITORIALS

WHY THE CANALS WERE DISCARDED

Upwards of a hundred years ago the development of inland waterways in the Middle West had reached a point that is surprising to one who goes over the old records. Canal building was as much discussed, and at least as well understood, by the general public at that time as highway improvement is today. The people knew what the canals were for, why they were built, and they knew also that these waterways were built with public funds.

It is not the purpose of the present discussion to give figures pertaining to the extent and usefulness of canals long since discarded; that may be done at another time.

The object of this discussion is to point out the fact that when the privately owned railroads rendered better service than the publicly owned canals the public very quickly "junked" their own investment.

Now, a hundred years later, if the publicly owned highways render better service than the privately owned short rail lines, can the public be blamed for turning from the rails to the highways? Are obsolescent utilities to be scrapped again? If so, or if not, how much weight should be assigned to the fact that this time the obsolescent utilities are privately owned, whereas on the other occasion they were publicly owned? If private ownership is a bar in the path of progress, isn't that a pretty good argument against private ownership?

THE GOOD ROAD

A good road, in the strictly modern sense, is one over which all legitimate classes of modern highway traffic can run rapidly, without interruption, and in safety, in any kind of weather, in any season of the year, and at any hour of the day or night.

Many roads are called good, by the motorist, if they are good part of the time and under certain favorable conditions. These same roads at other times may be very far from satisfactory. A road that is excellent today and bad a week from now is not a good road.

In the public mind the "good" road is often taken to include any road which is not hopelessly bad, or any road that is somewhat improved, or a road that under some circumstances is quite satisfactory. With standards rising higher all the time it is well to emphasize that a road is not worthy of the name "good" unless it functions properly at all times. The difference in first cost between such a road and one that is satisfactory only part of the time is not great, especially when maintenance costs are considered, for it is a well-known fact that the cost of maintaining a fair road is much greater than the cost of maintaining a good one.

ROAD SURFACES AND TIRES

Interesting statistics have been quoted from time to time showing clearly that, as one would naturally suppose, the mileage secured from automobile tires on the higher types of road surfaces is substantially greater than on the lower types. This fact, together with a corresponding saving in motor fuel, is one of the best economic justifications for improved roads.

There is another aspect of this subject which merits more attention than it has received, and that is the protection the motor vehicle operator secures against punctured tires when he is driving over a thoroughly modern road as compared with a road of gravel, for example. It would be interesting to know how many accidents are due to blowouts and punctures on cars travelling at high speed on country roads of inferior types. Probably many more accidents are due to sudden tire failures than is generally appreciated. Almost any car becomes unmanageable if a tire fails at high speed; under such circumstances the driver becomes almost as helpless as if the steering gear of his car failed to work properly. He may run into other cars or into the ditch

and may suffer any degree of disaster due to a bad puncture which deflates a tire as rapidly as a blowout.

It is seldom indeed that tires are punctured on hard surfaced roads. These surfaces are clean; they are washed clean by the rain and blown clean by the winds and the air currents induced by traffic. As a rule anything lying on the surface of such a road is easily visible and is easily avoidable. In the lower type roads, nails, bolts, glass, etc., that may cause bad punctures are not only often held by the road material in such position as to puncture tires, but are not easily seen and avoided, as they blend indistinguishably w ith the color and substance of the road surface.

A motorist can start out on good roads with new tires and feel secure against tire trouble, but the same tires may be punctured in the first hundred feet he travels over low type roads.

The insurance against bad and dangerous punctures of tires afforded by really good roads is one of the greatest advantages of such roads.

DOCTORS, LAWYERS AND ENGINEERS

A writer in this issue develops an interesting viewpoint with reference to the comparisons so often drawn, by engineers, between doctors and lawyers on the one hand and engineers on the other. We do not wish to take the edge from his remarks by giving them here in substance; the reader will naturally prefer to read the article entitled: "The Engineer as a Professional Man."

Such comparisons have led to much loose thinking and have delayed the engineer some years in his pilgrimage to the promised land. The conditions of employment surrounding doctors and lawyers are much like those under which the consulting engineer works, but are quite unlike those with which salaried engineers are confronted. One reason why discussions concerning the status of the engineer have been so unfruitful to date is that many arguments made to fit the man who is "called in" for a "fee" are applied to the salaried man on a steady job, and they just naturally do not apply to him at all.

One wonders if the word "professional" is not about as badly overworked as the word "engineer." Nowadays almost everybody who does anything styles himself an "engineer" of one sort or another, and so great has become the misuse of the word that it means one thing to one man and something else to another. In a similar way many classes are using the term "profession" as if it were identical with "vocation." Not long ago we saw a reference to "the overcrowded profession" and supposed, of course, it meant engineering, but not so. Reading on, the fact was disclosed that the particular overcrowded profession under discussion was manicuring. The barber is rated by some as an unskilled laborer, but he regards himself as a professional man and, when feeling right and properly encouraged, can make out a pretty good case for his rating of himself.

Time was when the contractor was just a contractor, and that was glory enough, but now he, too, is putting on airs and styling himself a professional man. Formerly, also, one spoke of professional men *and* business men. Now many men regard business as a profession and speak of the profession of business. They, too, can make out a good case for their usage of words.

So, what with one thing and another, confusion is becoming worse confounded. Perhaps the engineer might do worse than discard the professional title along with a lot of traditional professional notions, of the virulent ingrowing variety, and style himself just a business man and act accordingly. He would be of as much service to society, as he is now, and perhaps more to himself. The thought is not wholly unattractive.

INDEX TO VOL. LXIV

The index to Vol. LXIV of this magazine, for the months of January to June, 1923, inclusive, is now being prepared and will be ready for distribution by the end of July. A copy of this index will be sent free to anyone who requests it.

Many requests for this new index have been received to date and it is a pleasure to note that such requests increase in number every six months. Many subscribers have learned that it pays to preserve their copies of this magazine for while it is not thick it can not be said to lack depth.

The cost of binding six, or even twelve, copies together is small and the volume is not of such great bulk as to be a burden even to the man who moves occasionally.

PAYING FOR CONSTRUCTION AND MAINTENANCE OF CAR TRACK PAVING

(Editor's Note: A conference on the "Design and Construction of Streets for Street Railway Traffic" was held under the auspices of the Engineers' Club of Philadelphia in collaboration with other engineering societies and the following discussions at the conference are here reproduced as reported in "Engineers and Engineering.")

The first authority quoted is Mr. Geo. W. Tillson, Consulting Engineer, La Grange, Ill. His remarks follow:

There is no question that the presence of street car tracks, in a public street, are a nuisance. It is, however, recognized that they are necessary. If tracks and pavements between and adjacent thereto were always kept in good repair, it would be different. But owing to financial, as well as other conditions, this is not true; in fact, it is safe to say that until recent years the pavement in the railroad area in the cities of this country was in a deplorable condition. As the tracks are generally owned and operated by private corporations, the city's engineers have no direct way of having repairs attended to promptly. Franchises generally provide a method by which municipalities can have repairs made legally; the process, however, involves much red tape and loss of time.

It seems to be generally admitted that the railway company should make all repairs to the tracks, but, during the last few years, much discussion has taken place as to whether the company should lay and maintain the pavement in the track area. As a matter of fact, this obligation has been imposed upon nearly all street railways in the past. The question of this obligation being continued is not a simple one; rather it is quite complex. The pavement must be taken care of and the cost of the same paid for by the general public or two certain parts of the public.

If it is paid for by the railway company it becomes a part of first cost, and this, together with maintenance, must be provided for in the amount to be charged for each ride, and so will be paid by the riders. It is true that except within the last few years 5 cents has seemed to be the proper fare for a street car company to charge without regard to cost of road or size of the community in which the company is operating. Why this is so, no one knows. But when it is proposed that fares should be raised a great outcry goes up as if a 5-cent fare were sacred.

If, on the other hand, all paving work is paid for by the abutting property and the railway company does not pay any of its cost, it will all be charged to the abuttors.

The ordinary double track road practically uses 15 ft. of the most valuable part of the roadway and at times during the rush hours fills the street to such an extent that vehicular and even pedestrian traffic is very much impeded. Is it right, then, that the abutting property should pay for the pavement when its space is actually used by the railway company?

If neither the railway company nor the abuttors pay the cost, it must be provided by the city at large and the money raised in the tax budget.

It may be said, in answer to the argument that the cars in rush hours impede traffic and consequently damage property, that the existence of car tracks on a street enhances, rather than diminishes, property values on such a street. This may be so in an outlying district where there is no congestion, where the property is residential and where the owners wish to reach down-town sections quickly. But, for instance, take the loop district of Chicago, where practically every street has a double line of car tracks; can anyone question that if half of the street were free from tracks that the property on those streets would not be more valuable than on the car track streets? In a residential section the car track streets generally have a line of small merchants doing business on the street to supply local wants and so make some property more valuable, but the better residences will always be found upon the streets that are without tracks—and in almost every instance the residents of a well-built-up street will resist the construction of tracks on that street. It seems to the writer that in no case should the abutting property on a street be put to any extra expense on account of the existence of a car track. If anything, the amount of paving to be paid for should be less, as it is a well-known fact that the cost per yard for any pavement on a car track street is considerably more than on a street where there is no track. This is also true as to maintenance. During the years of 1913 to 1918, inclu-

sive, the cost of repairs to asphalt pavements in Brooklyn, N. Y., on street car track streets averaged $0.039, while on streets without tracks it was $0.022. This was on an amount of over 40,000,000 sq. yds. of pavement. Admitting, for the sake of the argument, that the abutting property owners are not to pay for the track pavement, there remains to be considered the general public and the car-riding public. These two parties must be considered together to a certain extent.

It is generally admitted that as a street car company operates in a public thoroughfare, where it has no inherent rights, that it must pay something for the privilege of operating. This is irrespective of payment for an inconvenience to, or interference with the general public. This right or privilege is generally called a franchise, and is given by some legally designated body. Coupled with this franchise are certain conditions with which the company must comply. The principal ones generally relate to pavements, snow removal and sometimes to special amounts to be paid for each car operated—and the rate of fare.

Previous to 1907, the Philadelphia Rapid Transit Company was required to pave from curb to curb all streets upon which their cars were operated. In that year, however, a contract was entered into between the city and the company by which the latter was to pay a lump sum of $500,000 annually. This relieved the company from all costs of paving, snow removal and other minor obligations. The contract also provided for a certain annual increase in the amount to be paid. The writer is told that the total amount now is about $550,000.

A street car company is organized and operated for profit. Whatever its expenses may be, whether of construction, maintenance or operation, they must be paid for by the people who ride, and the more stringent the conditions, and the more rigid the requirements, the more the company must earn to pay a reasonable dividend to its stockholders and the rate of fare must be adjusted to this, unless it be accepted as a fact that a 5-cent fare is proper for all street car companies without regard to any conditions whatever.

It may be said that such a discussion as this is purely academic, and not practical, as all companies interested now have franchises, and that in the next twenty years comparatively few new companies will be organized. This is undoubtedly true. But if franchise conditions are to be modified, the principles above laid down are pertinent.

Admitting that the company must pay for its franchise, the exact amount to be determined by general conditions, to be revised at certain intervals, if necessary, the principal conditions to be determined are: Amount of paving to be laid and maintained, if any; what shall be done about snow removal, very important in northern cities; and rate of fare. The amount to be paid to the city for any purpose affects the general public as well as the riders. It should not affect the stockholders, as they should be taken care of by the fare charged.

It may be said also that in the existing franchises the rate of fare has already been fixed. This is true, too, but if it be admitted that any condition of a franchise may be changed, all may, and consequently the rate of fare.

The last few years have pretty clearly demonstrated that it is impossible to fix all the conditions of a franchise that extends over a long term of years so that they will always be just to all parties, and when changes are necessary, they should be made in a fair and equitable way.

But, to get back to the question of franchise conditions, it does seem that any company seeking the right to operate a street railway in a public street or road should pay for that right, either as a lump sum or as an annual rental; also for what it costs to keep the streets in good condition in the portion it occupies at all seasons of the year. This last, it seems to the writer, means the construction and maintenance of the pavement in and between its tracks, and such a distance outside the rails as may be disturbed in repairing or laying new tracks; also removing the snow from the same area. These points must all be given careful consideration when the rate of fare is to be fixed.

As has been heretofore intimated, the writer does not believe that the franchise conditions should be irrevocably decided upon, but that provision should be made for their revision at certain intervals by a public service commission, or some similar body, or where none exists, by a court that has suitable jurisdiction.

As an academic proposition, are the above conditions too harsh to be imposed upon any railway corporation seeking a franchise? Should the general public be

charged for any of them? Should they not be paid for by the riding public that uses the cars? If the rate of fare be properly adjusted, it makes no difference to the company or to its stockholders. If the above line of argument be agreed to, it follows, of course, that the riding public, and not the general public, should pay for the cost of pavement construction and maintenance.

Coming now to the proposition of what should be done with existing railway corporations who question whether they ought, or ought not, to be required to lay and maintain the pavement in the railroad area, it seems to the writer that the principles herein laid down will hold good. Many franchises for street railway companies have been given in perpetuity for no cash payment, but requiring the companies to keep the pavement in repair, and providing for a rate of fare. If neither of these conditions can be changed, there is no use in arguing the question, and if one can, either or both can. Assuming this to be possible, why should not the fare be changed if cost of materials, labor and everything that enters into maintenance and operating expense has increased from 50 per cent to 75 per cent or perhaps more? The rates on steam railroads have advanced approximately 80 per cent. The wages and salaries of those who ride in the street cars have been raised to keep up with the new cost of living and if prices for any one activity remains the same, it is practically a reduction in cost to the users thereof.

The original contract of the New York subway was immensely profitable, but when the great system was established the first contract was merged in a new one with the consent of both parties. Many other contracts of various natures have been modified materially as a result of the changes brought about by the World War; it being recognized that these changes were so enormous, and such as could not be foreseen, that equity demanded a readjustment.

It will be urged that if it be proper to raise fares on account of unprecedented increases in costs, it would also be right to lower them when costs decrease. This is undoubtedly correct, and that is why the writer believes in a readjustment clause in any long-time franchise which is merely a contract under another name.

The writer believes that all investors in a deserving public utility should have a fair return for their money. Watered stocks, however, are different and should be treated differently. He believes further that, as a general proposition, where a needed public utility, operating under a long franchise, and in a business way can not pay dividends on account of the advanced costs of operating, it should be permitted to increase its rates for service rather than to decrease costs by modifying conditions.

Mr. J. A. Griffin, Chief Engineer of the Board of Public Works of Los Angeles, Calif., gave the following information on practice in his city:

The responsibilities of the street railway company as to cost of installation and maintenance of paving is practiced in our city along the following lines: The franchise or permit to use the street that is issued to the railway company contains a clause that they shall install and at all times maintain the same type of pavement on their right-of-way, which extends from 2 ft. outside the outside rail of one track to 2 ft. outside the outside rail of the other track, as is used on the balance of the street, unless special permission is granted to do otherwise. This method works out very well and practically no friction occurs between the street railway corporations and the city. In some instances where extensive paving programs have progressed very rapidly, the railway companies were unable to pave their portion at or near the same time the other portions of the street were paved, but in each such instance they altered the grades of their tracks and covered the dirt surface with screenings and oil to make their portion passable until such time as they could follow with permanent paving.

Mr. C. E. De Leuw, Consulting Engineer, Chicago, contributed the following to the discussion:

The present responsibility, in general, is to install and maintain all paving within the right-of-way of the companies. This obligation has arisen through the growth of the traction industry. In former days when horses were used to draw cars, the space between the rails, called the horse-path, was paved and kept in condition by the operators, in order to secure "good traction for their motive power." As traffic became heavier, the space between tracks was also paved by the companies in order to permit vehicles using the tracks to pass from one to the other track, in order to save time in pulling out ahead of street cars to per-

mit their passage. This step resulted in the entire right-of-way being paved at the companies' expense.

With the advent of electric traction, the need for paving was of much less import from the viewpoint of the companies—except to permit vehicles to cross tracks readily, to pull out ahead of cars, and thereby avoid delays.

During the period of the great development of electric traction there was neither regulation nor supervision on the part of the public; consequently, the surplus profits from operations were held entirely by the companies—profits which in many cases were large. The public, in attempting to reduce these profits where excessive, placed many burdens upon the operating companies, which tended to increase operating expenses, reduce dividends and to give some form of physical or service improvement to the public or to the car riders. These burdens were usually imposed as franchise obligations. This action usually resulted in an effective means of political control and utilized at times when the public demanded extensions to the property, or when franchises were under consideration for renewal.

With mounting operating expenses and rising fixed charges, due to the more costly investment in plant and in equipment, the necessity of fare increases, particularly during the war period, became a vital matter. From these facts there has arisen a decided swing towards "service-at-cost" franchises. This is the general tendency in electric traction circles today.

Any changes, which are not solely the result of creating transportation, which are assessed against the car rider, prevent his obtaining service at cost. Therefore, from the financial side alone, all charges, such as the maintenance of paving, sprinkling and sweeping the right-of-way, and the like, should be borne by the public rather than the car rider through payment of fares.

However, as track and paving are of intimate construction and design, and as the tracks can not be repaired without the removal of the paving, it is a difficult matter to draw a sharp line of demarkation in making a separation of the direct charges. Further, paving will be disintegrated should the rails be poorly secured to the ties or should the track foundation fail.

In consideration of the above remarks, it is suggested that a separation of track and paving be made, and that the burden of cost to the car rider be held to the lowest possible amount, as determined solely by the actual value he receives from his purchase of transportation. He should not be compelled to pay indirectly for the cost of anything which he does not and can not use.

If such a division were made and the charges and costs directly allocated, then "Service-at-cost" would be a verity.

THE ENGINEER AS A PROFESSIONAL MAN

(Editor's Note: The following discussion has its points. It was published as a letter to the editor of the Military Engineer for May-June, 1923. It was written by Charles H. Roe of Tarrytown, N. Y. Mr. Roe displays a real understanding of things as they are and he reports his findings in a virile style which should help engineers find out just where they fit into the scheme of things. What he says of doctors and lawyers is not what the average engineer writes when he holds these two old professional classes up as models for engineers to copy. Probably he intentionally overstates the unfitness of doctors and lawyers to serve as models for engineers; certain it is that the opposite view has been enlarged upon sufficiently. Since practically all doctors and the great majority of lawyers work for fees, while nearly all engineers are salaried men, comparison between these essentially dissimilar groups are worse than useless as they are misleading. Mr. Roe's advice to the engineer to get out of engineering if it doesn't reward him sufficiently, while good advice for the individual, is no solution at all in the broad sense affecting the profession as a whole, on the one hand and the public on the other. There will always be engineering work to do and it is the opinion of the editor of this magazine that it will be much better for the public, in the long run, if the men actually engaged in engineering are properly paid for their services. Mr. Roe's opinions are here reproduced as they undoubtedly are valuable, especially to the younger engineers, although it is not to be expected that all will agree with him.)

"We have read too much and heard too much to the effect that a man with technical training and ability will rise in his profession by sheer virtue of that training and ability, whereas that is far from

being true. I am convinced that promotion in modern industrial organizations, even tenure of position, in fact, does not depend upon ability, training, or experience, to nearly so great an extent as it does upon such irrelevant circumstances as family relationship; membership in church or lodge favored by superiors; inclination to be a 'good fellow,' meaning a penchant for petty gambling, boozing in a 'gentlemanly' manner, and telling funny stories one wouldn't repeat at a church social; and, finally, upon the existence or non-existence of a vacancy into which one can be placed.

"I dare say every reader can recall individual experiences in which young Mr. So-and-So was made superintendent of construction because his father was on the board of directors; or in which Mr. Thingumbob became very friendly with the 'Big Boss' as soon as the latter learned he belonged to the same lodge—net result, promotion for Mr. Thingumbob; or in which Mr. Whatsis was made head of his department because he was 'such a good mixer and all the boys liked him'; or in which Old Fuzzletop remained on his job for 17 years, a matter of great pride to himself, but effectually barring young Ambish from climbing into his shoes. All this is no indictment of any one or any circumstances; it is perfectly natural as long as human nature is human.

"The reason is obvious. Our superiors, those who 'hire' and 'fire' us as engineers, are mostly pawns of fate, despite their own opinions to the contrary. Perhaps only ten percent of them are in their positions because of merit and the other ninety percent are accidents of the types described above. What else, then, can be expected from men like that, then that they judge us by the same standards they were themselves judged by?

"My own solution of this problem is to start or acquire an industry of one's own. I assert most emphatically and believe positively that by virtue of his training the engineer will make a better business man, banker, chicken farmer, or garage keeper than any other type of man. Ergo, if an engineer meets misfortune or unpleasant experiences in other men's organizations, let him start an organization of his own. No one will deny that there are many more graduate engineers turned out of our colleges today than the country needs. If anyone wants to know where they go, he can obtain a little interesting information from the yearbooks published by the engieering societies or various publications of the colleges. 'John Jones, M. E., '08, vice-president Smith & Jones, fur importers' may not be a representative entry but it is not an unusual one. So to the engineer dissatisfied with his lot as an employe, I quote the old army expression—'If you don't like this war, go and start a war of your own.'

"But I do not like the suggestion about an organization of engineers to promote their own material welfare. How many engineers can say they have a sincere, honest respect for the legal profession? How many of us believe that doctors of today are the self-effacing alleviators of suffering that the country practitioner of past generations was? Then why should we debase ourselves by patterning after them? The lawyer deals with very fallible, man-made criteria of justice. Too often he forgets the justice in the effort of applying the criteria. Also, how much sincerity can we expect to find among a profession the members of which, in practice, are always lined up in pairs, whereby one out of each pair must necessarily be wrong, yet he must simulate sincerity even if he does not feel it in declaring his side right? Doctors deal constantly with the physical results of human erring. They delve in loathsome filth. They know more of sin than a father confessor. There are many true noblemen among them, but they are very conspicuous. What wonder that the doctor often becomes more interested in the size of his fee than in the relief of suffering? The engineer handles the immutable laws of God as his working tools; he converses with the stars; he measures the cataract and bridges the chasm; he makes the desert bloom; he flings his voice into space and contrives means to transport men and materials with chained lightning; he measures the huge sun and a tiny electron and he discusses eternity and infinity with a famliiarity that would have sent him to the fiery stake a few centuries ago. It may be idealistic, it may not be practical, but I would rather see engineers as they are than bound into an organization to demand 'adequate' remuneration and to 'enforce' respect from others.

"I have heard a great deal about the low pay of engineers. I have also heard similar complaints from other professions. I can not state that engineers as a whole are paid well or otherwise, for I do not know—that is a matter the statisticians can easily settle—but I have known en-

gineers earning very large salaries and I have known doctors who never acquired enough to own their own homes and lawyers who stooped to the most despicable practices to make a very modest living. It is a matter that no individual can judge of his own experience; let someone trot the figures out and see if engineers are underpaid.

"The state registration law? Yes, by all means, but let the engineer continue his way as he is, a student of nature, a builder, a dreamer of dreams, knowing that he is right even if the gold-grubbers sneer and say he is wrong; let him continue thus rather than to organize and demand increased pay, like a striking laborer, or insist upon respect like a shavetail insisting upon a salute."

HIGHWAY TRAFFIC INSPECTION FORCE AUTHORIZED IN PENNSYLVANIA

The Pennsylvania State Highway Department is laying plans for the inauguration of the traffic inspection force authorized by the legislature in the motor law recently signed by the Governor, as announced by Paul D. Wright, Secretary of Highways, in the following statement:

As soon as possible traffic officers will be placed on Pennsylvania highways. These men are provided for in the section of the Act of 1923 which amends Section 12 of the Act of 1919, governing motor traffic. This amendment authorizes the Secretary of Highways to employ such men as in his discretion are deemed necessary to the enforcement of the penal provisions of the motor laws. Inauguration of this force will not only result in greater safety to the users of highways, but will conserve the State's resources, because we shall put an end to truck overloading which has been the most active agent in road wear and destruction.

Our traffic officers will pay particular attention to these evils: The overloading of trucks; speed of motor vehicles—and particularly the speed of trucks, and the misuse of headlamps. No truck will be permitted to use Pennsylvania highways when it carries a load greater than that specified for the particular class in which it is registered. No truck will be permitted to travel faster than the rate specified for the class in which it is registered. Our traffic force will drive from the roads that five per cent of vehicle operators who through carelessness, ignorance, or intent, endanger the lives and property of pedestrians and the 95 per cent of drivers who obey the laws and rules of the road. Pennsylvania highways will be unhealthy places for intoxicated drivers. So-called speed-demons will be curbed. The traffic force will be looking for those drivers who roar through the State utterly regardless of the rights of the other fellow.

We shall end the glaring headlamp evil. Accidents at night occasioned by the use of illegal lamps are too frequent. At this time nearly 150 headlamp lenses and devices have the approval of the Department. A great many of them are obsolete and dangerous. We shall re-examine the entire number and disqualify those which do not meet modern qualifications. A stop will be put to the use of lamp bulbs greater in candlepower than those permitted for a particular lens. Motorists so careless and indifferent that they use improperly focused headlamps will be rounded up.

It has been impossible heretofore properly to regulate the use of Pennsylvania highways. The result is the existence of modern Dick Turpins who are as dangerous to road-users as were their ancient predecessors. Because of these outlaws the average man takes his life in his hands when he goes upon a journey—particularly upon Sundays and holidays. The legislature has given the Department of Highways authority to safeguard the roads and their users—and we propose doing it.

Pennsylvania's traffic inspection force is to be uniformed. Secretary Wright and Benjamin G. Eynon, Registrar of Motor Vehicles, have not yet decided upon the style or color of these uniforms. The force will be mounted upon motorcycles. Certain members engaged in enforcing the law relating to truck weights will use motor cars in which their road scales will be carried. The number of men in the new force has not been decided. The law did not fix a limit, saying merely that the Secretary of Highways may employ such men "as in his discretion are necessary."

Another section of the new motor laws which will result in money saving to the taxpayers is the clause giving the Department authority to regulate the weight of trucks and loads at certain seasons of the year. Secretary Wright and his Deputy, William H. Connell, prior to next winter will announce regulations which will govern trucks on stone roads or roads other than a durable type during those seasons of the year when the highways are affected by frost. This is an innovation in

Pennsylvania, but a number of other American states have been regulating truck loads for years. During the recent highway conference called by Governor Pinchot a New England highway commissioner told of a fleet of overloaded trucks which in passing over a road as the frost was leaving did damage totaling $100,000. Users of Pennsylvania highways during the spring months this year observed on macadam roads the damage done by trucks carrying too great loads.

It is believed the advance guard of Pennsylvania's traffic inspection force will be on the roads within a month.

SOME RECENT LARGE WATER WORKS PROJECTS

By Dabney H. Maury, Consulting Engineer, 1445 Monadnock Block, Chicago, Ill.

Within the last two or three years the cities of Denver, Norfolk and Tulsa have undertaken water works projects of more than usual magnitude and, in a general way, the principal features of these projects are here discussed.

Denver

In 1918 the city of Denver purchased the water works system of the Denver Union Water Company. It had been in litigation with this company or with its predecessors for nearly 40 years, and as a result of this litigation each party to the controversy had employed a large number of engineering experts, practically all of whom were men in the front rank of their profession and of most excellent reputation.

Shortly after the purchase of the water works system, the Board of Water Commissioners, to whom its operation and maintenance were entrusted, endeavored to secure a bond issue of $4,000,000 for much needed improvements. Largely as a result of opposition on the part of one of the local newspapers, the bond issue was defeated, and the city has several times since been on the verge of a serious water shortage.

In 1921 the Civic and Commercial Association of Denver, in its efforts to bring about a solution of Denver's water supply problem, appointed a committee of seven Denver engineers, with instructions to recommend to the Water Commissioners three engineers who should constitute an Engineering Board of Review and who should be charged with the duty of studying the large amount of available data relating to the water supply and of recommending to the City improvements required to meet present and future necessities.

As the result of the recommendations of this committee, the Board of Water Commissioners retained Colonel Herbert S. Crocker of Denver, Mr. Harry T. Cory of Los Angeles, and the writer, as a Board of Engineering Review. Colonel Crocker was promptly elected chairman of the board. In view of the fact that all of the engineers who had prior to this time been connected with Denver's water supply, had been retained by one party or the other to the litigation, the engineers composing the Board of Review were practically the first against whom no charge of partisanship, based on the manner of their employment, could be brought; and they were also the first who were charged with a general review of all available data, and with the preparation of a general and comprehensive plan for future development.

The bulk of Denver's water supply already comes from the South Platte River, and all future increases in the supply must be made by combining storage on the South Platte watershed with additional water taken from the Colorado River on the west side of the Continental Divide and brought through tunnels into the watershed of the South Platte.

Most of the 100 miles of existing conduits are of wood stave, of various ages and in various stages of decrepitude. The principal improvements contemplated are to be secured by the issue of about $7,300,000 worth of bonds.

To the south of the Platte Canyon filters lies the upper watershed of the South Platte. The possibilities for future development here are large, not only in the valley of the South Platte itself, whose flow can be very largely conserved, and its yield augmented, by storage in a great number of advantageous locations, but also because of the fact that if additional water can be secured from the Colorado River with the consent of the Colorado Commission, and brought across the Continental Divide through tunnels, that same water can be stored in reservoirs up the Canyon, and let down as desired. The power possibilities also, while for the present somewhat remote, and susceptible of only gradual development, are quite large, running up above 100,000 horsepower; the development of power being made possible by the construction of the same reservoirs which will be required

for the storage of the city's water supply.

The essential feature of our report was the recommendation for the abandonment of everything that would militate in any way against the creation and maintenance of the terminal storage at Marston Lake. Marston Lake has an earthen embankment. It is as safe against destruction as it would be possible for any storage reservoir to be, because the embankment is low, old, and has settled very thoroughly. It stores some six billion or more gallons of water, and by raising its embankment slightly, this storage can be considerably increased. It lies at an elevation well adapted to supply water by gravity to Denver's distributing reservoirs, located within the city at Ashland Avenue and at Capitol Hill.

Denver's water system has been built up piece-meal and its component parts have never been properly co-ordinated in one comprehensive and harmonious design. The fact that there were at times four different companies in simultaneous operation, combined with long and bitter litigation, made it impossible for the companies to develop any one comprehensive plan.

Since the city acquired the plant, the Water Commission has done its best with the inadequate and very much run-down water works which it inherited, but has had no funds with which to carry out any plan for rehabilitating the works or for increasing the supply.

The first installment of the supply system for bringing water from the south to Marston Lake would consist of stretches of cut-and-cover ditch following the curvature of the side hills, the stretches of ditch being connected by siphons across the ravines. The ditch sections would have a capacity of 225 mgd. and the first set of siphons would have a capacity of 75 mgd. Two other sets of siphons of equal capacity would be added later as needed. There is already a good 60-in. wood stave pipe leading from the intake in Platte Canyon at such an elevation that it can supply a limited amount of water to this conduit. Other water from the Platte Canyon Reservoir, delivered into that reservoir by the High Line Canal, in which the city has certain water rights, can be fed into the existing conduits, which, for the remaining period of their useful life, will be maintained to aid in bringing water down to the city, as they do at present.

Later on, with the progressive development of storage on the South Platte watershed, new tunnels and ditches will take the place of the 60-in. wood stave pipe and will supply to their full capacity the ditches and siphons leading to Marston Lake. From Marston Lake, a 66-in. conduit will be laid to the south limits of the city, where it will split into conduits of smaller size, connected to the distribution mains and reservoirs in the city. Two additional conduits of like size will be built as required. At least half a million dollars will be spent in the city itself, improving the local distribution facilities.

The slow sand filters at Platte Canyon, and the very old wooden tub filters at Willard and Marston Lake, will be replaced by modern fireproof mechanical filters northeast of Marston Lake.

Marston Lake is a pivotal and very important feature of the proposed new system. It will store a month's supply for Denver when the consumption is twice what it now is, and will thus give ample time to repair any break in the conduit lines leading down to it from the south. There is, however, no adequate outlet from Marston Lake and such an outlet is essential. It is exceedingly important not to have to drain or lower Marston Lake while building the outlet. At the same time it is vitally necessary that the integrity of the embankment be not endangered during construction. Consequently, a scheme was devised by which a crib, open at the bottom at first, should be sunk by excavating from within, without any pumping whatever; and when this crib should have reached its level, it was then arranged to close its bottom with concrete and to connect to this crib two rows of piling extending 140 feet or more into the lake. Then, by special devices, two lines of 72-in. cast iron pipe were to be lowered from trusses set across these rows of piles. When the pipes reached their place, they would be connected to the crib. From the crib there would lead out to the north three lines of 60-in. pipe, two of which would be plugged for the present, one of them being extended to the first unit of the filtration plant.

This first unit would have a nominal capacity of 64,000,000 gals. per day, based on a rate of 150,000,000 gals. per acre per day. Ample aeration and sedimentation would be provided. Aeration is particularly necessary in treating the Denver waters, because of the formation of algae in the shallow portions of the large lakes. From the filtration plant the first conduit would lead to the southwest corner of the

city. The filter plant could be increased by building on extensions, bookcase fashion, up to 192,000,000 gals. of rated capacity. Denver is now operating its old wooden filters at rates running up to 200,000,000 gals., per acre per day, and obtaining very fair results. It is possible that with better aeration and coagulation, better water could be obtained at even higher rates.

In addition to the $7,300,000 required for these immediate developments, something like $30,000,000 more will be required for the completion of the larger problem, estimated to supply Denver when it shall have a population of one million.

Norfolk

Prior to the war with Germany, Norfolk's water supply had for many years been taken from shallow lakes northeast of the City. At the same time the Norfolk County Water Co. was supplying territory to the north and east of the City, and some territory within the City limits itself, with water which it obtained in part from wells and lakes near Norfolk's lakes, and in part from the North Landing River through eight miles of 24-in. wood stave pipe leading to the company's pumping station.

The Company was thus competing with the City not only in territory outside of the City and through which some of the City's large mains extended, but actually within the limits of the City itself. Furthermore, the City's sources of supply were deficient in watershed and stream flow, but were equipped with a surplus of storage capacity; whereas, the Company's relatively important watershed on the North Landing River was without adequate storage and without any suitable site for developing storage.

It was obviously to the interest of the City of Norfolk to purchase the plant of the Norfolk County Water Company and consolidate the two systems, and the writer, who had been especially assigned by the War Industries Board to the development of water supplies for all Government activities in the Hampton Roads District, including the Army, Navy, Housing Corporation, and Shipping Board, strongly urged the consolidation of the two properties as the quickest means of securing a much needed increase in supply to meet the war time necessities.

Owing to a delay (in no way the fault of the City) in completing the pumping station necessary to deliver the North Landing River waters into the Norfolk lakes, and also to an unprecedented drought, the City found itself short of water in the winter of 1919-1920. As the result of complaints of insufficiency of supply at the Naval Base, where the per capita consumption was over 250 gals. per day as against less than 75 gals. per day in the City of Norfolk proper, a Congressional Committee met in Norfolk to consider the curtailment of naval activities in that vicinity. The speaker was called upon to testify at the hearings, at which it was satisfactorily demonstrated that the City within a short time would be in a position to supply even the excessive requirements of the Naval Base.

As an evidence of its good faith, Norfolk installed immediately, at a cost of nearly half a million dollars, an emergency connection to the Dismal Swamp Canal, knowing when it did so that no permanent use would ever be made of this water, which contains at times upwards of 400 parts of swamp color.

In the meantime the writer was called upon to report on the best method of making a large and permanent increase in the City's water supply, and one which should be susceptible of development to meet the growing needs of the City for practically all time to come. His report recommended the immediate construction of the Lake Prince project, a project which had long been dear to the heart of Mr. Walter H. Taylor, Norfolk's very efficient City Engineer and Director of Public Works.

The report having been approved, work was promptly started on the plans and specifications in the office of the Director of Public Works, the writer being retained as Consulting Engineer to revise or approve the plans and construction methods. Most of the plans were prepared originally in Mr. Taylor's office, Mr. Norman Z. Ball, with a staff of draftsmen, working under Mr. Taylor in the design of the various portions of the system. The construction work was under the direct supervision of Mr. Taylor, assisted by Messrs. David A. Decker, Norman Z. Ball, W. R. Galt, John D. Miller, John W. Vaughn and others.

The Norfolk Naval Base lies to the north of the City, the Norfolk lakes to the northeast, and the new Lake Prince development to the west. Norfolk's supply, amounting to a minimum of 14,000,000 gals. per day of available supply in a dry season, is taken from the lakes to the northeast, supplemented, as stated, by

the water from North Landing River, which is brought down into these lakes. The available water supply from the existing sources was barely sufficient for present needs and no more water could be developed to the east of the City. There was one small stream feeding Lynnhaven Bay that might have been utilized, but apart from the fact that it was not large enough to pay for its development, the importance of the local oyster industry would probably have prevented its use. The two streams which Mr. Taylor had long ago selected as best for the supply lie 20 miles to the west. As the initial step in the program it was decided to dam the southerly one of these two streams, thus forming the reservoir now known as Lake Prince, and to pipe the water thence down to the City.

The next development will be the damming of the northerly stream to form Lake Bensten, connecting it with Lake Prince by a tunnel. Following that, water can be pumped into the Lake Prince watershed from the Blackwater and Nottoway Rivers, which have a watershed of 400 square miles. The average rainfall is upwards of 40 ins., and the development of all of these streams will provide enough water for nearly a million people. A pipe line eight miles in length will bring the waters of the Blackwater and the Nottoway into the watershed of Lake Prince.

The Lake Prince dam is about 30 ft. high, with a spillway some 200 ft. in length, at an elevation of 25 ft. above the tide. A small electric pumping station delivered water into the pipe line leading to the City. The pipe line has a capacity, with 200 ft. head at the upper end, of about 16,000,000 gals. Lake Prince will store 3,700,000,000 gals., and will give, with that storage, more than the 16,000,000 gals. required. The damming of the next stream to the north, and the completion of the tunnel from it to Lake Prince will add another 14,000,000 gals. With 14,000,000 gals. per day from the lakes to the east, 16,000,000 from Lake Prince, and 14,000,000 gals. from Lake Bensten the total supply would be 44,000,000 gals. and not until Norfolk's requirements shall have reached this amount will it be necessary to bring additional water from the Nottoway River.

There was a good deal of food for thought in the selection of the proper sort of pipe for the line from Lake Prince to the City. Most of the line is 36 ins. in diameter, while parts of it for various reasons were made only 30. We had at our disposal cast iron pipe at an enormous price; reinforced concrete pipe, a somewhat untried article at that time; and wood stave pipe, of which everybody was more or less suspicious. A careful analysis was made of the relative costs of these three types of pipe, and their advantages and disadvantages were stated, and were then, for the purposes of comparison, reduced as nearly as possible to dollars and cents. After allowing for the shorter life and greater vulnerability of wood stave pipe, offsetting that to some extent by the fact that the capacity of cast iron mains is less per inch of diameter in the beginning, and decreases very rapidly in the Norfolk territory, because of the acids in the swamp water; taking into consideration as well as we could the unknown factors with regard to reinforced concrete pipe, we finally determined that if the cost of wood stave pipe would be represented by about 10, the cost of concrete pipe would be represented by about 11, and the cost of cast iron pipe by 20. This comparison was made when the price of cast iron pipe was about $73 per ton, f. o. b. Norfolk.

As a result, it was decided to use wood stave pipe in those parts of the line where it seemed absolutely certain that its use would be attended by the least possible danger. Analyses of the soil were made and all of the conditions were considered as carefully as possible, and we finally used 52,000 ft. of wood stave pipe, about 32,000 ft. of reinforced concrete pipe, and 13,000 ft. of cast iron pipe, approximately half of which was submarine pipe.

The laying of all of the submarine pipe was carried on under the direction of Mr. Taylor, the writer having practically nothing to do with it, except to give a suggestion or two from time to time. The work was most efficiently and successfully executed. When the makers of concrete pipe submitted their first proposal, the only pipe they had to offer was one in which bars or wire mesh construction were the only reinforcement. They were loath to recommend this reinforcement for pipes designed to carry more than 110 ft. of head, not because they were afraid of any excessive tensile stresses in the steel, but because they feared they could not entirely prevent leakage through the thin and more or less porous concrete walls.

At Norfolk they developed a pipe in

which a portion of the reinforcement was put into a thin steel shell, electrically welded. The results with that pipe were really very satisfactory, and after that pipe was introduced we bought more concrete pipe than we had originally planned to buy, and put it across territory where it would have to carry upwards of 150 ft. head.

The official leakage tests on the concrete pipe gave an average leakage throughout the entire 33,000 ft., under the maximum working pressure, of 83 gals. per 24 hours per inch of diameter and per mile of pipe. That is an exceedingly good record, and is considerably less than some authorities say that cast iron pipe will leak. The speaker personally believes that well laid cast iron pipe ought to be somewhat tighter than that. As the contractor's bid was based on 125 gals. per 24 hours per inch-mile, he earned a bonus which the City gladly paid.

The leakage on the wood stave pipe lines in Norfolk has never been fully and accurately tested. It was slowly but constantly diminishing at last accounts. When tested last year it was in the neighborhood of 300 gals. per inch-mile, under the maximum working pressures. This year the leakage in 12,800 lin. ft. of 30-in. wood stave pipe at the upper end of the supply line was accurately determined by tank measurement under an average head of about 65 ft., which is about one-third of the maximum head to which the pipe will be subjected. Under this low head the leakage was found to be only 60 gals. per inch mile. As the leakage in most wood stave pipe increases more rapidly with pressure than is the case with other kinds of pipe, it is believed that the leakage in this part of the line under a head of 200 ft. would probably be a little over 200 gals. per inch mile. This the speaker considers a creditable result for pipe of this sort.

Tulsa

The City of Tulsa is conspicuous among American communities of its size for its phenomenal growth and development during the recent past. While this development has resulted, primarily, from the magic wealth of oil, no man can remain long in the City without realizing that the personnel and civic pride of those who are prominent in the City's affairs have had far more to do with the City's rapid strides than would ordinarily be the case in such a community.

Not only is the City one of the most modern and up-to-date in this country, but on every side one is impressed with the energy, intelligence and patriotic teamwork of the leaders of all of the civic organizations.

For years past the City has been getting its supply from the Arkansas River. The water is made perfectly safe and sanitary by filtration, but as it contains from 300 to 3,000 parts per million of salt, it can not be used for drinking nor for boiler purposes. It has been estimated that the citizens of Tulsa pay annually from $350,000 to $500,000 for bottled waters. In 1921, the citizens voted a bond issue of $6,800,000 to bring water 60 miles from Spavinaw Creek in the Ozark Mountains. As at that time the population of the City was not much over 75,000, this bond issue represented the assumption of an obligation of more than $90 for every man, woman and child in the City.

It is doubtful whether history could show a larger per capita bond issue for water works extensions in any city of comparable size. New York's $175,000,000 for her Catskill supply seems small when the relative populations of the two communities are considered.

The citizens of Tulsa would not, however, have voted this large bond issue had not the Chamber of Commerce assured them that the work would be placed in the hands of men of standing so high in the community that all their acts would be above suspicion. The personnel of the present Spavinaw Water Commission complies with this specification to a remarkable extent. It is composed of men of proven courage, intelligence and integrity, practically all of whom are at the head of some of the City's most important business institutions; and these men are giving constantly, unselfishly, and without compensation, their valuable services to the enterprise.

How they stood the acid test was shown when at a letting of about five and one-half million dollars worth of contracts, on Sept. 25, 1922, they had the wisdom and courage to reject unanimously a bid on six contracts which was apparently $900,000 lower than the aggregate of the six next lowest bids on each of these contracts; and also to reject unanimously a bid on two contracts which was apparently, though not actually, $150,000 lower than the next lowest bid on the same two contracts.

The original report on which the Spavinaw project was based was prepared by Messrs. Trammell and Holway, who were later retained to prepare the plans and specifications and supervise the work of construction, the writer being retained by the Board as Consulting Engineer on the plans, specifications and supervision.

Pursuant to an understanding arrived at between the Board and Messrs. Trammell and Holway, subsequent to the lettings, Mr. Holway now has direct charge of the construction work, Mr. Trammel being retained to advise Mr. Holway when necessary. The writer, as Consulting Engineer for the Board, is under obligation to visit the work twice a month during the progress of construction. The work has started all along the line and is being pushed with all the energy possible.

The Grand River is the western limit of the Ozark Mountains, the hills coming down sharply to its banks. Spavinaw creek is a beautiful mountain stream draining about 400 square miles, and having a minimum flow of perhaps 17,000,000 gals. per day. The water is clear, reasonably soft and almost never turbid. About 11,000,000,000 gals. of water will be impounded by a dam 50 ft. in height, with a spillway 800 ft. long. This dam is about 3,500 ft. in total length. The spillway section will be of solid concrete, gravity type, and there will be about 2,700 ft. of earthen embankment with heavy concrete core wall. From this dam a gravity pipe line, the first 28 miles of which will be 60 ins. in diameter, leads toward the City. At the lower end of the 60-in. pipe there is a tunnel which, with its approaches, is 10,000 ft. in length, and which will have an inside diameter of 84 ins.

From this tunnel westward there will be 25 miles more of 54-in. concrete pipe, which will bring the water to an earthen reservoir at Mohawk. This reservoir will have a capacity of 500,000,000 gals. At that point a new pumping station will be built, and at some later date a filtration plant. Tentative layouts for the aerators, pumping station and future filtration plant have been made. The water will be pumped from this station against a total head of 350 ft., including friction, through four miles of 30-in. force main, into a 10,000,000 gal. reinforced concrete distribution reservoir, with concrete roof covered with soil and turf. These items, together with some large additions to the distribution system, will complete the new development for the present, although later on a filtration plant will be built opposite the Mohawk pumping station.

The little town of Spavinaw, Okla., will be flooded by the waters of the dam. This is one of the oldest towns in that comparatively new country. There is one old stone building there said to have been built by the Mormons when they trekked through toward Utah. About 1,800 acres of land will be flooded, and some 800 acres of that will have to be cleared.

The City Water Board very wisely and economically acquired the flowage rights in old Spavinaw by starting a new town, which the Board equipped with water supply and sewerage and sanitary facilities, and laid off in attractive streets. The Board gave two lots in the new town for one in the old, and removed the buildings besides. Land damages and property damages were disposed of very cheaply in that way, and the new town now contains many more houses than the old one, and they are building them as fast as they can put them up.

The foregoing matter is from a paper presented by Mr. Maury before the recent annual meeting of the American Water Works Association.

FOR THOSE WHO ARE FOND OF FINE OLD WRITING

By Harry W. Levy, Engineer-in-Charge, Division of Design, Borough of Manhattan, Municipal Bldg., New York, N. Y.

—Introduction—

Probably one of the first real efforts toward a comprehensive City Plan for any of our large cities was made by the Commissioner of Streets and Roads in the City of New York back in 1807.

From the year 1624, the date of the first real effort at colonizing in America by the Dutch, up to the adoption of this comprehensive street plan, or as it is familiarly termed the "Commissioner's Map of 1807," the development of the street system of New York City was merely a matter of growth, a condition in which we find a parallel in the start of all old cities.

John Randel, Jr., was the engineer employed by the Commissioners to make the necessary surveys and maps, set monuments, etc., and it is believed that the successful termination of this great work, within four years of its inception, was largely due to his efforts and ability.

The governing reasons for the adoption of the rectangular street system are quaintly but forcefully described in the report which is appended hereto. The reader should bear in mind that two of the principal factors to be considered in city planning today, namely, vehicular traffic and density of population with its intensive building development, had not at that time become manifest.

"The Commissioner of Streets & Roads in the City of New York appointed in and by an act relative to improvements touching the laying out of streets and roads in the City of New York and for other purposes passed the third day of April in the year of our Lord one thousand eight hundred and seven according to the Form and Effect of the said act Remark on the Map hereunto annexed:

"That as soon as they could meet and take the oath prescribed they entered on the duties of their office and employed persons to make surveys of Manhattan Island, which they personally reconnoitered, so as to acquire the general information needful to the correct prosecution of their work which has been much delayed by the difficulty of procuring competent persons on those acconomical terms which they prescribed to themselves, and by seasons peculiarly unfavorable.

"That one of the first objects which claimed their attention was the form and manner in which the business should be conducted: That is to say whether they should confine themselves to rectilinear and rectangular streets or whether they should adopt some of those supposed improvements by Circles, Ovals and Stars which certainly embellish a plan whatever may be their effect as to convenience and utility. In considering that subject they could not but bear in mind that a City should be composed principally of the habitations of man and that strait sided and right angled houses are the most cheap to build and the most convenient to live in. The effect of these plain and simple reflections was decisive.

"Having determined, therefore, that the work should in general be rectangular a second and in their opinion an important consideration was so to amalgamate it with the plans already adopted by individuals as not to make any unimportant change in their dispositions. This if it could have been effected consistently with the public interest was desirable not only as it might render the work more generally acceptable but also as it might be the means of avoiding expense. It was therefore a favorite object with the Commissioners and pursued until after various unfruitful attempts had proved its extreme difficulty, nor was it abandoned at last but from necessity. To show the obstacles which frustrated every effort can be of no use. It will perhaps be more satisfactory to each person who may feel aggrieved to ask himself whether his sensations would not have been still more unpleasant had his favorite plans been sacrificed to preserve those of a more fortunate neighbor.

"If it should be asked why was the present plan adopted in preference to any other, the answer is, because, after taking all circumstances into consideration, it appeared to be the best, or, in other and more proper terms, attended with the least inconvenience.

"It may to many be matter of surprise that so many vacant spaces have been left and those so small; for the benefit of fresh air and consequent preservation of health. Certainly if the City of New York were destined to stand on the side of a small stream, such as the Seine or the Thames, a great number of ample places might be needful. But those large arms of the sea which embrace Manhattan Island render its situation in regard to health and pleasure, as well as to the convenience of commerce, peculiarly felicitous. When therefore, from the same causes, the price of land is so uncommonly great, it seemed proper to admit the principles of acconomy to greater influence than might, under circumstances of a different kind, have consisted with the dictates of prudence and the sense of duty.

"It appeared proper, nevertheless, to select and set apart, on an elevated position, a space sufficient for a large reservoir when it shall be found needful to furnish the city, by means of aqueducts or by the aid of hydraulic machinery, with a copious supply of pure and wholesome water. In the meantime, and indeed afterwards, the same space may be consecrated to the purposes of science when public spirit shall dictate the building of an observatory.

"It did not appear proper only, it was felt to be indispensable, that a much larger space should be set apart for military exercise as also to assemble, in case of need, the force to defend the city. The question therefore was not, and could not be, whether there should be a grand

parade but where it should be placed and what should be its size, and here again it is to be lamented that in this late day the parade could not be brought further south and made larger than it is without incurring a frightful expense.

"The spot nearest to that part of the city already built which could be selected, with any regard to acconomy, is at the foot of those heights called Inklangbergh in the vicinity of Kips Bay. That it is too remote and too small shall not be denied; but it is presumed that those who may be inclined to criticism on that score may feel somewhat mollified when the Collector shall call for their proportion of the large and immediate tax which even this small and remote parade will require.

"Another large space almost as necessary as the last is that which, in no distant period, will be required for a public market. The City of New York contains a population already sufficient to place it in the rank of cities of the second order, and is rapidly advancing towards a level with the first. It is perhaps no unreasonable conjecture that in half a century it will be closely built up to the Northern Boundary of the Parade, and contain four hundred thousand souls. The controuling power of necessity will, long before that period, have taught its inhabitants the advantages of deriving their supplies of butchers' meat, poultry, fish, game, vegetables and fruit from shops in their neighborhood. The dealers in those articles will also find it convenient, and so will those from whom they purchase, to meet at one general mart.

"This has a tendency to fix and equalize prices over the whole city. The carcass butcher, gardner, farmer, etc., will be able to calculate with tolerable accuracy on the rate at which the supplies he furnishes can be vended, and the reasonable profit of the retailer being added, will give a price for the consumer; varying rather by the quality of the article than by any other circumstance. It is no trifling consideration that by this mode of supplying the wants of large cities there is a great saving of time and of the articles consumed.

"To a person engaged in profitable business one hour spent in market is frequently worth more than the whole of what he purchases, and he is sometimes obliged to purchase a larger quantity than he has occasion to use, so that the surplus is wasted. Moreover the time spent by those who bring articles of small value from the country in retailing them out bears such great proportion to the articles themselves as to increase the price beyond what it ought to be. In short, experience having demonstrated to every great aggregation of mankind the expediency of such arrangement it is reasonable to conclude that it will be adopted hereafter, and therefore it is proper to provide for it now. Neither is it wholly unworthy of consideration that the establishment of a general mart will leave open the spaces now appropriated to that object in parts of the city more closely built than is perfectly consistent with cleanliness and health.

"The place selected for this purpose is a salt marsh and from that circumstance of inferior price tho in regard to its destination of greater value than other soil. The matter dug from a large canal thro the middle, for the admission of market boats, will give a due elevation and solidity to the sides; and in a space more than three thousand feet long and upwards of eight hundred wide, there will, it is presumed, after deducting what is needful for the canal and markets, be sufficient room for carts and wagons without incommoding those whose business or curiosity may induce them to attend it.

"To some it may be a matter of surprise that the whole island has not been laid out as a city. To others, it may be a subject of merriment that the Commissioners have provided space for a greater population than is collected at any spot on this side of China. They have in this respect been governed by the shape of the ground. It is not improbable that considerable numbers may be collected at Harlem before the high hills to the south westward of it shall be built upon as a city, and it is improbable that (For centuries to come) the grounds north of Harlem Flat will be covered with houses. To have come short of the extent laid out might, therefore, have defeated just expectation; and to have gone further might have furnished materials to the pernicious spirit of speculation."

—Concluding Notes—

When one stops to consider the times and basic facts then at hand to guide these commissioners in laying out their street system, it must be admitted that this is a remarkable piece of city planning. The population at that time was largely concentrated in the area south of

Houston Street. Provisions were brought in mostly by means of sailing vessels which docked in the section along the East and North Rivers. The main traffic was to and from the water front. The principal means of transportation were by stage coach, carriage, wagon and cart. Later it became apparent that more north and south avenues should have been provided. Therefore, Madison and Lexington Avenues were cut through midway between 3d and 4th avenues and 4th and 5th avenues, as laid down on the Commissioner's Map, before property development had made such a proceeding financially impossible, as would be the case today.

In a recent report by the Chief Engineer of the Board of Estimate and Apportionment, he states that "it has been frequently urged that if the street system of 1807 had been planned in such a way as to locate the short blocks along the east and west streets instead of the reverse, there would have been, say, 40 north and south streets instead of the 15 which we now have at 42d Street, and that in this case there would have been no congestion problem today. This claim is open to very serious question. If the north and south streets had been made 60 feet wide, as it seems likely would have been the case, there would have resulted some 80 lanes of traffic instead of the 55 which we now have, but each lane would have had to accommodate both slow and fast moving vehicles. Of the lanes now available, nearly one-half can be treated as for fast moving vehicles, each adjoining one for those of slower motion, these, in my opinion, providing freer movement to an extent more than sufficient to offset the fact that they are less in number than would have been available if the street system had been reversed."

THE WATER WORKS COAL PILE

By Donald H. Maxwell, Principal Assistant Engineer, Alvord, Burdick & Howson, Engineers, 8 S. Dearborn St., Chicago.

The recent increased cost of coal and the troubles experienced in getting a sufficient supply and of the right quality have brought the coal pile forcefully to the attention of the water works superintendent.

Although the amount of coal required for water works pumping in the United States seems small by comparison with the estimated total coal consumption for all purposes of about six tons per capita, it is nevertheless a very considerable amount, and is estimated at approximately three million tons per year. In future years it is likely that much more than this will be required, for even if better economy can be practiced in the use of coal by water works plants, the savings will be more than offset by the increased demand for water by the growing city population. This city population may reasonably be expected to at least treble. When that time arrives the coal consumption for public water supply on the present basis will be approximately ten million tons per year.

In the meantime the general expansion of industry tends to increase the market for coal while the supply is well understood to be definitely limited and capable of development only at increased cost as the more accessible veins and better grades are worked out.

It is thus apparent that the problem of the coal supply and of the economic utilization of coal in the water works plant is not one of momentary interest alone but destined to be of constantly increasing importance.

Coal Savings Possible

There is no doubt but that the water works coal pile, taken as a whole, can be very much reduced. The consulting engineer is in a position to note many instances where pumping plant efficiency might be increased and others where pumpage might be reduced. It is rather striking, for instance, to note that in our second largest city, supplied with water by ten large pumping stations of good efficiency the waste of water in distribution is so great that the estimated possible saving in coal by metering the services would amount to nearly 100,000 tons a year. This plant is, of course, exceptional but instances taken at random will be given later on that will be sufficient to indicate that there is in the aggregate, a very considerable waste of coal in water works plants that can be overcome by giving closer attention to boiler room economy, to efficient pumping and to the distribution of water without unnecessary waste.

Developments in Steam Plant Economy

The first requisite to coal economy is efficient equipment. Great strides have been made in the development of pumping plant economy since many of our older water works plants were equipped. In contrast to the hand fired return tubular

boiler of small horsepower delivering saturated steam at 80 lbs. pressure to duplex pumps of very low duty, modern practice calls for stokers, water tube boilers in large units, with superheaters and with good accessory equipment for maintaining high efficiency, and delivering steam at from 200 to 300 lbs. pressure and superheated 100 to 200 degs. The steam is utilized in cross-compound or vertical triple pumps with test duties ranging from 120 to 180 million foot pounds per 1,000 lbs. steam.

The effect of this change on the coal pile is shown in part (except for superheat) by the accompanying diagram. This diagram does not take account of such auxiliary equipment as boiler feed pumps and the incidental uses of coal for station heating, etc., nor does it allow for variation in load. The station duty for a given set of equipment would, therefore, be less than indicated by the coal rates shown on this diagram. The diagram is based on coal having 12,000 B. T. U. per pound.

By inspecting the diagram we see that vertical triple expansion engines of 160 million duty using saturated steam supplied by boilers operating at 70 per cent efficiency would require 0.3 tons of coal to pump one million gallons 100 ft. high. On the other hand with compound direct-acting low duty pumps of 30 million duty using steam supplied by boilers of 50 per cent efficiency would require 2.2 tons of coal to accomplish the same result. One plant would consume seven times as much coal as the other to do the same pumping and it is a fact that may of our smaller steam plants compare no more favorably than this with the more modern high duty station.

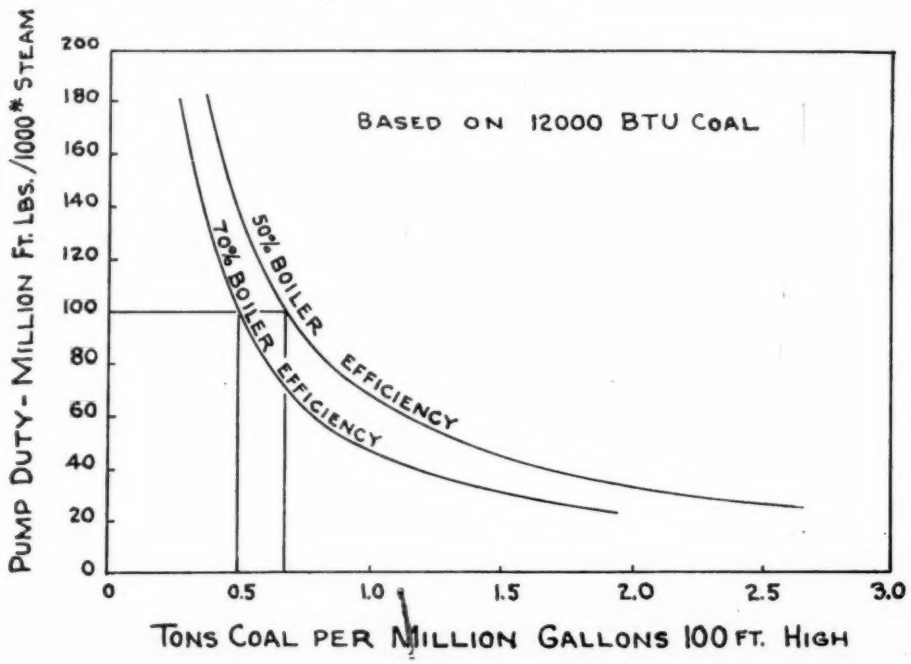
Advantage of High Pressure and Superheat

To understand the advantage in high steam pressure and superheat, it should be borne in mind:

(1) That steam engine efficiency increases with the steam pressure, amounting in turbo-centrifugal pumps, for example, to about 1 per cent decrease in steam consumption for each 10 lbs. increase in steam pressure.

(2) That, in general, it does not take more coal (to an appreciable extent) to generate steam at relatively high pressure than at low pressure.

(3) That engine efficiency increases with superheat, the gain with turbo-centrifugal pumps, for example, being approximately 1 per cent decrease in steam consumption for each 12 degs. increase in superheat. The great advantage of superheated steam in reciprocating engines is that it does away with cylinder condensation (if superheated enough), so that all of the steam entering the cylinder is available to do useful work throughout the stroke.



(4) That the additional heat required to superheat steam is much less than the heat saved by the engine so that there is a saving of coal. Assuming 100 deg. superheat, this fuel saving amounts to about 4 per cent with a turbo-centrifugal unit, 8 per cent with a triple expansion engine and much more with compound and with simple engines.

Limitations of Water Works Plants

The water works plant is long-lived compared to the industrial and electric power plant. The opportunities of business expansion, particularly in electric power production, make it good business policy to use only the most modern and efficient equipment. The coal bill in these plants is a relatively large part of the cost of power and accounts for the wholesale discarding of comparatively new equipment and even entire plants to make way for more efficient units of larger capacity in great central stations that will enable the utility to command more business.

The water works plant cannot be rejuvenated in this sweeping way. The business of selling water is in most cities fully developed and can only increase in proportion to the growth of the city. The water works pumping station represents a comparatively small part of the total plant investment and the coal bill is also a small part, comparatively speaking, of the total annual cost of the entire plant, including fixed charges. Furthermore, the requirements for fire protection make it necessary, particularly in the small plant, to carry a relatively large reserve boiler and pump capacity which is idle most of the time.

From these facts it is seen that the water works plant must move slowly in the procession of increased plant efficiency. Only occasionally when an entirely new plant is built to replace an outgrown and obsolete plant does the engineer have the joy of doing what he would like to do in making the plant up to date in efficiency of equipment. The more usual case involves more or less important additions to existing equipment, the limitations of this old equipment influencing at times very largely the character and efficiency of the new. It is not always financially practicable to change over to 200 lbs. boiler pressure and 100 degs. superheat, for instance, in a plant with heavy investment in low pressure pumps and boilers that are still good. The fixed charges on proposed new equipment must always be weighed against the estimated saving in cost of coal, and coal is not high enough yet to warrant the sweeping replacements in the average water works plant that have been good business policy in some electrical power plants.

Planning for the Future

Even though radical changes in pumping station equipment may not be justified when renewals are necessary, the superintendent has an opportunity at such times which should not be lost sight of, to map out an improvement program involving the entire plant. It would be most desirable, for instance, in replacing a boiler to make a survey of the plant and its future requirements and as a result, perhaps find it worth while to install a boiler, at comparatively slight increased cost, capable of withstanding a future higher steam pressure and arranged for the installation at a later date of superheaters. Then when the time comes to make pump replacements or additions the boilers will not be a handicap. Judicious provision for the future in this way will do much in the course of time to improve the small water works station efficiency without sacrificing useful equipment.

Boiler Plant Operation

Meantime the water works operator must be contented to make the best use of the equipment now in hand. Even though the low pressure plant with low duty machinery must continue operating on this basis for some years a great deal can often be accomplished in these plants to reduce coal consumption by close attention to the details of operating that make for efficiency. The watch-word throughout the plant should be: "save the heat units." It might be said that intelligent and conscientious operation of a hand-fired low efficiency boiler installation is even more important for coal economy than in a plant with high efficiency equipment.

Coal saving is not possible without measuring and recording the internal workings of the plant. Between the heat input and measure of work output, there may be very large preventable waste of energy amounting to from 25 to 50 per cent of the coal pile in a poorly maintained plant. So it is not sufficient to know merely the tons of coal purchased and the plunger displacement, and yet, astonishing as it may seem, plants are occasionally met with in which even this meagre information is not obtainable in a satisfactory manner.

The efficient operator must know the pounds of coal burned per hour for a given heat output in steam. He must

know whether his customary methods of firing give the best results with the fuel at hand. He must know the effect of his practice in draft regulation as to whether the boiler is being unnecessarily cooled by too much excess air on the one hand, or on the other hand whether unburned gases are being wasted up the stack from insufficient supply of air to the furnace, and among other things he must know the effect of removing soot and boiler scale and how often it pays as a practical proposition to do this.

In a word, the operator should know whether he is wasting coal in the boilers. To find this out he needs the equipment and the interest to make routine boiler tests and periodic flue gas analyses.

An intelligent boiler room force and careful training in efficient methods are essential to economical operation. Furthermore, a suitable bonus system based on coal saved would be a valuable stimulus to interest in a coal saving program, if the possible savings seem sufficiently great to warrant it.

Pump Room Operation

Pump room operation has a very large influence on the coal pile. The coal robber in this part of the plant is pump slip, though the preventable loss at the steam end may also be considerable.

The output of every pump room should be metered at the station unless there is some other convenient method of checking up on the pump slip, at frequent intervals. The use of venturi meters on discharge lines has become quite general, but there are still many plants which lack proper equipment of this kind. These plants are as a rule paying heavily for it in the coal pile.

The writer has had occasion to observe some startling results from high pump slip, and there is good reason to believe that this is one of the principal causes of coal waste in many of the stations that lack proper means of measuring the water delivered by the pumps.

Table I shows the result in one plant of reducing pump slip. The records of this plant for several years show a continual increase in the tons of coal burned per million gallons pumped. The coal bill finally became so high that it was decided to have the pumps rebuilt. The effect of improved efficiency of the steam end and of reducing the pump slip is very strikingly illustrated by a reduction in the coal consumption amounting to 67 per cent of the coal burned in 1922. Comparison of the 1922 pumpage with that of the two

TABLE 1—EFFECT OF REDUCING PUMP SLIP ON THE COAL PILE

Year	Plunger Displacement, Million Gals.	Coal Burned Tons
1919	263.1	1,124
1920	299.9	1,288
*1921	304.8	1,264
1922	237.9	770

*Rebuilt pump back in service in November.

Coal saved in 1922, 518 tons—67% of 1922 coal pile.

preceding years shows a very marked reduction in pumpage as indicated by plunger displacement.

Table II shows the effect on the coal pile of introducing a high duty pump to do the work formerly carried on by low duty pumps. In this plant under the same conditions of operation the high duty pump accounted for a saving of over 1,000 tons per year amounting to 25 per cent of the 1914 coal pile.

Table III is a rather striking illustra-

TABLE II—EFFECT OF HIGHER DUTY PUMP ON THE COAL PILE

Year	Pumpage Mil. Gals.	% of Time New Pump Used	Coal Tons	Coal Per Mil. Gals. 100 ft. High Tons
1910	1,839		4,626	1.01
*1911	1,919		4,873	1.01
1912	2,090	60.9%	4,749	0.965
1913	2,241	90.7	4,403	0.842
1914	2,272	92.6	4,562	0.810

*Cross-Compound pump of 142 million test duty installed.

Coal saved in 1914, 1,030 tons—25% of 1914 coal pile.

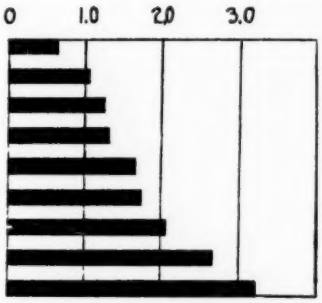
tion of the very large coal saving sometimes possible in a comparatively small plant by eliminating excessive slip in a high test duty cross-compound pump. The saving in this case was at the rate of approximately 1,600 tons per year, although inspection of the records tended to show that the excessive slip found on test had lasted only about four months. The record of plunger displacement indicated, however, that up to within one week of the test the slip had been materially higher than indicated by the test, and had been partly corrected by replacing pump valves.

TABLE III—VALUE OF TESTING PUMP SLIP AS MEASURED BY THE COAL PILE

Average daily pumpage	12,000,000	Gals.
Slip	3,750,000	Gals.
Slip reduced to	700,000	Gals.
Total head 153 ft.		
Coal per mil. gals. 100 ft. High	0.923	Tons
Coal saved per year	1,570	Tons

TABLE IV—COMPARISON OF COAL CONSUMPTION OF STATIONS DOING DOUBLE PUMPING.

PLANT	AV. DAILY PUMPAGE MIL. GALS.	TOTAL HEAD FT.	COAL TONS	COAL PER MIL. GALS. 100 FT HIGH TONS
A	8.83	256	5,317	0.61
B	4.98	240	2,672*	1.05
C	2.3	280	2,905	1.23
D	0.78	263	648	1.30
E	1.34	221	1,768	1.63
F	2.81	140	2,500	1.74
G	8.98	180	11,940	2.02
H	3.5	190	6,400	2.65
I	2.39	253	7,060	3.2



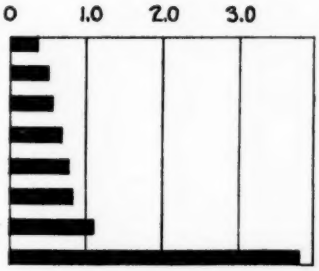
* 7 Months Period

Table IV is shown to illustrate the great difference in coal consumption between stations of the same general type. These are all double pumping stations in small or moderate sized cities operating for the most part under direct pressure. Plant "A" is an eastern plant burning Pennsylvania coal. The others are western plants burning Indiana or Illinois coal. The high coal consumption of plant "G" may be partly attributed to wide range in low lift pump head. In Plant "H" it is due partly to poor plant design. In Station "I" the poor showing is due in part to very inefficient low lift pumping from the use of over-sized electric centrifugals, the low lift pumping being accomplished at an overall efficiency of 15 per cent for pumps and motors.

Table V is shown to indicate the typical low coal rate that is expected of well designed and operated modern stations doing single pumping, and to contrast with them the old fashioned stations with low pressure boilers and low duty pumps. Plant "A" is the North Point station at Milwaukee, equipped with vertical triple expansion engines of high test duty of about 180 million foot pounds. Plant "B" is an efficiently operated small station burning Pennsylvania coal in hand-fired boilers and pumping with cross-compound engines against constant head. "C" represents the newest and most efficient of the Chicago pumping stations, pumping direct pressure with vertical triple and turbo-centrifugal pumps against a total lift of about 115 ft. Steam is generated by water tube boilers operating at 175 lbs. pressure. "E" represents the average of all Chicago stations considering steam pumping only. At three of the Chicago stations a large amount of pumping is done by motor driven centrifugals using central station current. At these stations the coal duty has been greatly decreased from their former performance which is probably to be accounted for by the unfavorable load on the steam plant. 22nd St. now shows a coal rate of 1.41 tons per

TABLE V—COMPARISON OF COAL CONSUMPTION OF STATIONS DOING SINGLE PUMPING.

PLANT	AV. DAILY PUMPAGE MIL. GALS.	TOTAL HEAD FT.	COAL TONS	COAL PER MIL. GALS. 100 FT HIGH TONS
A	62.6	211.5	18,954	0.399
B	3.86	240.	1,800	0.53
C	76.5	115.3	18,452	0.572
D	10.9	283.5	3,237*	0.684
E	603.	109.2	184,368	0.768
F	6.15	251.	4,562	0.810
G	0.65	294.	770	1.10
H	0.5	217.	1,500	3.79



* Five months period

million gallons, 100 ft. high compared with 0.83 in 1910 and 68th St. shows a coal rate of 1.3 tons compared with 0.85 in 1910.

Plant "D" is the new Des Moines station with stoker fired boilers, 200 lbs. steam pressure and 100 degs. superheat pumping with turbo-centrifugals of 143 million foot pounds test duty. It should be noted that this plant operates on Iowa coal containing from 8,300 to 8,800 B. T. U. per pound. The boilers on test showed 72 per cent efficiency at full load and 66.5 to 168 per cent overload. The plant operates direct pressure. It should be noted particularly that this plant burns a much lower grade of coal than the Illinois steam coal used at Chicago.

Station "F", the old Des Moines pumping station, should be compared with Station "D". This station, with hand-fired return tubular boilers and a cross-compound pump of 140 million test duty operating on 125 lbs. steam pressure required 20 per cent more fuel than the new station to accomplish an equivalent amount of pumping.

Station "G" indicates good performance in a fairly well maintained plant operating under 90 lbs. steam pressure and duplex compound pumps in good condition operating direct-pressure under a high head. Station "H" in contrast to "G" represents very poor performance in a plant having equipment of the same general character and burning just as good coal. This latter plant showed 50 per cent boiler efficiency on test and 25 per cent pump slip.

These few illustrations show that although some pumping plants are operating on a highly efficient basis, there are others where large quantities of coal are being wasted. In some of these instances the fault lies in the plant installation, and can only be overcome by putting in better equipment. In others a great deal can be accomplished to improve the plant efficiency by systematically checking up on pump slip, boiler firing methods, draft regulation, and all the other details of operating that affect the size of the annual coal pile.

The foregoing paper by Mr .Maxwell was presented at the recent annual meeting of the American Water Works Association.

A COMPARISON OF FLOOD CONTROL MEASURES

By Harry Taylor, Brigadier General, U. S. Army, Assistant Chief of Engineers.

It may be well to ask at the outset what are the causes of floods? The answer is, briefly, abnormal rainfall. This rainfall may be either in the shape of what is popularly known as a "cloudburst," such as occurred at Pueblo, Colo., in June, 1921; in the shape of heavy, long-continued rains, such as produced the floods in the lower Mississippi River in February and March, 1922, or heavy rains falling on snow or frozen ground, such as produced the floods which devastated Dayton and other cities of Ohio a few years ago. Warm winds blowing on a heavy blanket of snow may also produce a serious flood. Floods of this character are most common in the Pacific Northwest where a warm southwest wind, known as a "Chinook" wind, occurs during the winter months and causes the snow on the mountains to melt with great rapidity. The floods caused by the so-called cloudburst are usually local in character and commonly occur on small streams. Floods caused by long, heavy rainfall usually cover a large territory and it often happens that such rainfall will produce a flood in the main stream when none of the tributaries is subject to excessive flood. This occurred recently in the lower Mississippi, when that stream carried an unusual flood, but all of the lower tributaries carried moderate quotas. The floods caused by rains falling on snow or frozen ground generaly affect an area intermediate between the other two types.

Control of Floods

Outside of the Mississippi Valley the people of the United States ordinarily give little thought to the control of floods. It is only when some serious flood occurs that attention is focused on the prevention of a repetition of the disasters caused by such flood, and then the matter is of extreme interest for a short time, with all sorts of remedies proposed. Dayton, Ohio, is one exception. It is characteristic of the American people that when we suffer from any cause such as a flood, a contagious disease, or war, we are wildly enthusiastic for steps to prevent a repetition of the disaster, but as soon as the time of stress has passed, we forget that trouble has occurred and delay taking the steps necessary to prevent a repetition. This is well illustrated by the present attitude of the

American people toward the army. Five years ago there was nothing too good for the army. Today, many seem to desire its absolute abolition, forgetting that it is an insurance against trouble in the future. I wish I could believe that we will never be involved in another war. I wish also that I could believe we will never have a disastrous flood, but I am certain that floods will come until we know how to control the distribution of rainfall, and I am equally certain that the services of the army will be required in the future.

The control of floods appears to be considered by the majority of our people as a simple problem. It is true that different people have different solutions. The most common solutions are reforestation, reservoirs at the sources of the streams, levees, outlets or spillways, and straightening and enlarging river beds. We frequently have other solutions suggested, as for example, one proposed to install boilers on the banks of the Mississippi River to evaporate the flood waters, thus causing clouds to form and produce rain over the Middle West where needed.

In the solutions proposed, the control of floods is quite commonly linked with other beneficial effects, most commonly with waterpower development. It is generally assumed that the same work which will control floods will produce power, improve navigation, and provide drainage. One very troublesome problem that comes before the engineer department is the problem of the Fox River and Lake Winnebago, Wisconsin. At the outlet of Lake Winnebago are constructed two dams provided with gates for controlling the water outflow from this lake. The lake is surrounded by flat land over which the flowage rights were purchased and paid for by the United States some 50 years ago. Since that time these lands have been sold and the buyers in many cases have apparently made their purchases unaware of the rights of the government. Invariably, during floods on this stream, the people above the dams insist on the gates being open so as to permit the water to flow out rapidly; the people below the dams insist on the gates being closed so as to prevent the water from coming down on them; power interests on the lower river desire to have the water retained and released during periods of low water for the purpose of developing additional power; for the benefit of navigation, the flow should be as uniform as possible.

Reforestation Not a Practical Remedy

With reference to reforestation. I desire to say that I am a thorough believer in a sensible and sane system of reforestation. I believe that the proper exploitation of our few remaining forests and intelligent reforestation is one of the great needs of the country. Reforestation has sufficient merit in itself to stand on its own feet and should not be confused with flood control. The price of lumber today is a sufficient argument for planting trees without attempting to associate forestry with the climate or with flood conditions on our rivers.

There appears to exist in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation. The influence of forests on stream flow has been extensively discussed both by European and American engineers since Gustav Wex, imperial and ministerial counselor and engineer of the improvement of the Danube River at Vienna in 1873 submitted a series of papers on the decrease of water in springs, creeks and rivers which were translated into English by the late General Weitzel, C. E.

There is a great diversity of opinion on the subject, some maintaining that the cutting of forests will ultimately convert Europe into a Numidian desert, while other claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application is fraught with great difficulty.

When a country acquires a population of 100,000,000 people, the forest primeval which existed when it was settled has to disappear. It is all very well to bemoan the fact that if the black walnut which once covered the state of Ohio had not been destroyed and was sold as lumber at the present market rates, it would equal the assessed valuation of the property of the state, but there have now been created the cities of Cleveland and Cincinnati, whose people can not live on black walnut alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and the same is true of the forests in other sections of the country. The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest cul-

ture, and only a limited reforestation, then, is possible.

The effect of forests on rainfall in Europe has been carefully investigated and the records at many European localities, where the rain has been recorded for long periods, fail to show any tendency to a pronounced change of fall in recent years.

Study on Merrimack River

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. The best existing data in this country of which I am aware are those for the Merrimack River, on which a daily record of the stage of the river has been observed since 1849, on a gauge established below the dam at Lawrence, Massachusetts. An exhaustive study of this stream was made about 12 years ago by Col. Edward Burr, C. E., and a report submitted by him which is published as a government document. Colonel Burr's conclusions as summarized for the basin of the Merrimack River were as follows:

"Deforestation of the basin continued progressively from the early settlements until about 1860-1870, and since that period forested areas have increased through natural causes by 25 per cent or more of the entire basin, notwithstanding the continuance of lumbering operations.

"There has been no decrease in precipitation in the basin as a result of deforestation or any increase with the reforestation of 25 per cent or more of its area. The precipitation for 50 to 90 years at points within the basin or within a few miles of its borders shows tendencies, or cycles, that bear no relation to the change in forest areas.

"The average run-off through the river varies with the precipitation over its basin, and the percentage of run-off to precipitation is not appreciably affected by forest changes as great as 25 per cent or more of the basin. The frequency of floods has not been decreased by reforestation or increased by deforestation.

"Exceptionally high floods have occurred at intervals without respect to forest conditions. Flood heights have not been decreased by forestation or increased by deforestation, and the principal characteristics of floods are unaffected by forest changes. The duration of flood stages and the amount of run off during such stages have not been affected adversely by deforestation or beneficially by reforestation.

"Deforestation has not lessened the height of the river at low water or increased the duration of low-water periods, and the reforestation of 25 per cent or more of the basin has not had any beneficial effect on low stages of the river.

"Variations in stream flow are determined essentially by variations in climatic conditions which move in irregular cycles independent of forest changes. Correct deductions as to climatic variations and as to varying conditions of stream flow may be expected only from the analysis of satisfactory records covering periods of 60 years or more, and conclusions drawn from records extending through 40 years or less may, and probably will, be misleading or incorrect."

Reforestation and the Mississippi Floods

The greatest flood of the Mississippi at St. Louis occurred in 1844; the next largest in 1875. On the Great Lakes the high water of 1838 is the greatest on record. On the Ohio, the flood of 1884 exceeded that of 1913 at Cincinnati; and that of 1832, while 5 ft. lower at Cincinnati, was 5 ft. higher at Pittsburgh than the 1913 flood. The gauge records at the bridges over the upper Mississippi which cover a period of 30 years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusion of the European forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

It is argued by some that if the floods were occasionally high, they would not be as frequent with reforestation. Again let us search the records of the past. It is hopeless to expect to reproduce by reforestation the forest growth that existed at the close of the Civil War. Yet, from 1857 to 1867, the Mississippi Valley was visited by a most remarkable series of great floods. These floods occurred as frequently as any that have been recorded since that time.

It requires from 20 to 50 years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We are more vitally interested in the height that a river will attain in the next few months

than in what will occur in the year 2022 or 2072.

Reforestation as a means of reducing flood heights on the Mississippi River, for example, requires the conversion of too much farm land into a wilderness to be practicable. The waste land that can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

Reservoirs

Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the Great Lakes a practical illustration of flood restraint by means of natural reservoirs. Reservoir control of the Mississippi River was discussed by Humphreys and Abbot in 1858, and on the upper Mississippi the Corps of Engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country. These reservoirs have been most successful, not only for increasing the low-water discharge of the Mississippi River above St. Paul, the purpose for which they were constructed, but also for reducing floods in that portion of the river.

There is nothing novel in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low-water discharge at St. Paul and markedly reduce flood heights, yet 100 miles farther down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefitted or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

Reservoir Problem on the Mississippi

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Illinois, having an area of 7,000 square miles, slightly less than that of the state of Massachusetts, and a depth of about 15 ft., assuming that it would be empty when the river attained a bankfull stage.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouth of the tributaries to the headwaters, their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. If the prevailing winds in the early spring are from the Southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the South, reservoirs will be required on the streams of Ohio, Indiana and Illinois; a slight varying of the wind will produce a flood in the upper Mississippi while, if it blows from the Southeast, the principal sources of trouble will be the Red, the Arkansas and Missouri Rivers. To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The 1913 flood affords data for determining the effect of such a system of reservoirs. When, on April 2, 1913, the gauge at Cairo attained a height of 54 feet, there was flowing down the Mississippi River at least 2,000,000 cu. ft. of water per second. It requires about 11 days for a flood wave to be transmitted the 966 miles between Pittsburgh and Cairo. On March 22, the Pittsburgh gauge read 5.3 ft., which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In 10 days a flood travels the 858 miles between St. Paul and Cairo. On March 2, the reading of the St. Paul Gauge was 0.5 ft., corresponding to a discharge of the Mississippi of about 2,500 second-feet. In 8 days the effect of a flood at St. Joseph, Missouri, is felt at Cairo. On March 25, the gauge at St. Joseph read minus 0.1 ft., representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St. Paul, and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharge by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2d of April came principally from the White and Wabash and the lower tributaries of the Ohio, and after the water of these rivers started to subside, the flood from Cincinnati, though increasing from 57 to 69 ft. on the Cincinnati gauge,

could increase flood heights at Cairo less than 1 ft. The flood of 30 ft. at Pittsburgh on March 28 produced its effect on the Cairo gauge on April 8. It prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars, and its effect on the flood height of the lower Mississippi could not possibly have exceeded 6 ins.

General Limitations on Reservoirs

Great floods do not arise from average conditions, but from exceptional conditions such as are caused by heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir, to be effective, must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the flood crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality they necessarily prolong the period during which the river remains at a high stage.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power, and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water, as a rule only the excess can be used for power development. In the case of the new San Francisco water supply, now under construction, a large amount of power will be developed, but in this case the main storage reservoir is over 4,000 ft. above the city and the topography is such that at one point the supply line drops about 1,300 ft., and at another point it drops 1,000 ft. in a nearly vertical line, giving an excellent opportunity for a power development at a minimum expense and without interfering with the main object of the construction. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs, both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have occurred in the past.

Levees

Levees, properly located and constructed, are an effective means of protection against floods. Levees have been used for many years on the European rivers and to a great extent for the protection of the lands bordering the Mississippi River. At the present time there are 1,779 miles of effective levees in place between Rock Island, Illinois, and the mouth of the Mississippi. These levees contain about 400,421,000 cu. yds. of material. The levee system protects about 27,628 square miles of land. At the present time, the question of providing additional outlets or spillways on the lower Mississippi is being given great consideration. That the spillway will cause a temporary lowering of the flood water is beyond question, but it is not quite so certain that the ultimate effect of a spillway will be beneficial to the Mississippi, for there is a possibility that the abstraction of the water will cause shoaling of the channel below the spillway, which may produce serious results in time. Levees combined with channel enlargement and spillways are being used in the flood control of the Sacramento River. The spillways, however, are of secondary importance, the main dependence being placed upon levees and the straightening and enlarging of the channel of the river near its mouth, so as to afford a freer escape of the flood waters.

In locating levees, care must be exercised not to place them so near the banks of the river as to unduly crowd the stream and reduce the cross-sectional area sufficiently to prevent the escape of flood waters without causing their rise to such a height that they will overtop the levees. The great tendency is for the owners of the land on each side of the stream to crowd the levee as close to the bank of the stream as possible, leaving too little space for the escape of flood waters, with disastrous results to both sides.

The foregoing matter is from an address before the American Association for the Advancement of Science.

NOTES ON WATER SUPPLY SERVICE AT CHARLESTON, SOUTH CAROLINA

By J. E. Gibson, Manager and Engineer, Water Department, 14 George St., Charleston, S. C.

There is no branch of municipal service that receives greater condemnation in cases of failure to function adequately or properly than the water works. The slightest tendency of the water to be off color, off taste or otherwise lacking in quality or quantity, raises a storm of protest from the consumers, and the presentation of a bill that is higher than is usual or expected, will raise protestations that echo long after the rendering of and settlement of the bill.

Generally speaking, when we desire a commodity we buy without regard to the cost or value of the article itself. We all love to pamper ourselves, but the moment a service or commodity becomes a necessity, we take a niggardly attitude toward the party furnishing the service and all thought is lost of equity or justice in respect to the amount to be paid for the service rendered or for the commodity itself. Particularly is this so when the commodity enters into our daily life, such as gas, electric light and water supply service.

The Water Supply

The City of Charleston, acting in its legal capacity, caused to be dammed what was formerly a tidal salt water stream, thereby creating a large storage reservoir. The land area flooded by this reservoir exceeds three square miles, and in addition thereto, there have been purchased or perpetually leased, 5,000 acres of land to protect this reservoir from pollution. The inflow of fresh water soon displaced the original impounded salt water so that we now have approximately 3,000,000,000 gals. of fresh water in storage. The 42 square miles of drainage gathering area tributary to this reservoir is heavily wooded with pine, cypress, gum and similar growth in the swamps bordering the main stream and branches, and the water leaches out the coloring matter from the roots of the trees and the deciduous leaves of this wooded area so that the impounded water has a high color and is known as a peaty or colored water.

Generally speaking these waters carry no turbidity and are unusually free from contamination, the trouble, however, is to remove the coloring matter so that the water may meet the aesthetic approval of the consumer and be a satisfactory supply for household and manufacturing purposes.

To remove this organic coloring matter from the water it is necessary to treat it with sulphate of alumina, then pump it to large sedimentation basins where the coagulated coloring matter is allowed to settle out. The water is next filtered through modern type concrete filters where the remaining coagulated matter and pathogenic bacteria are filtered out, after which it is treated with sodium hydroxide to restore the alkalinity and soften the water for household, laundry and manufacturing use, and, finally it is sterilized with liquid chlorine that it may be absolutely free of pathogenic germs should by chance any have passed the filters. The water is then pumped into the mains for the use of the consumer. The service is maintained to all intents and purposes 100% of the time, in fact, should the service fail for a few hours only, many activities of our city would cease to function, street railway, gas, electric light, laundries, hospitals, sewerage systems, household operations and the Fire Department would be entirely helpless.

Fortunately for us there are a few cases where the water supply systems of our complex and congested life centers have failed. Drought is the most usual cause of curtailment of supply, and the cities of North Carolina and Pennsylvania have just recently passed through such a condition, due principally to the short sighted policy of the governing powers in denying the water departments the necessary funds and credits to extend their works and increase their water supply resources.

Occasionally we learn of the failure of a city's water supply due to the breaking down of the pumping machinery or the failure of the main supply lines. Such an instance occurred to the main conduit supplying the city of Montreal, Quebec, several years ago and a like occurrence to the new 250-mile water supply conduit of the city of Los Angeles, Cal., shortly after its completion. Our neighboring city of Greensboro, N. C., was subject to a similar occurrence last spring, and for a number of days water had to be hauled in tank wagons and distributed to the

citizens. The losses caused to the community by such failures cannot be reckoned in dollars. We spend large sums of money for highway improvements, autos, carriages, boats, travel, sports, entertainment and pleasure, but as above stated become niggardly, stingy and grasping when the essential commodity, water, has to be procured and paid for. What more essential commodity enters into our daily life than water and how willing we should be to pay for such service, when it serves us so faithfully as food, drink, laundry, the extinguishment of fires and last, but by no means least, as a vehicle for the removal of body and household wastes. We have expressed some of the foregoing statements in rather forceful language and it is not intended as a criticism or complaint on our part but only in an effort to drive home the necessity and importance of the water supply to our citizens.

Rate Making

When public water supplies were first introduced, the rate or amount to be paid by each property or household was assessed at a flat rate or charge in an effort to divide up the cost of the operation and maintenance of the water works plant among those using the service.

This flat rate is a heritage of the early pioneers and was probably first introduced by Appius Claudius in Rome. There were no modern plumbing appliances as we know them today, and therefore the use of water was confined principally to the ordinary household uses of cooking and washing. This flat rate system winks at the extravagance and wastefulness of the individual at the expense of the public. It is admittedly inequitable, conducive to wasteful habits and poor plumbing. The rate is made higher or in excess of the legitimate amount in an effort to cover these abuses. This form of rate today is frowned upon by all water works men, utility commissions and the courts.

Rate making has received more attention in the last 15 years than in all previous history of the water works business. In fact, it received very little attention until the introduction of the modern water meter. There are today three general forms of rates for metered water, they are:

1. The flat or uniform rate system where the water is charged for at a stipulated price without regard to quantity used or service rendered.

2. A minimum demand rate and sliding scale for water used in excess of minimum.

3. A service and demand charge rate with sliding scales for water used.

The objection to the first form, the flat or uniform charge, is that it does not distribute the burden equitably upon the consumers. It permits a property to obtain valuable service and puts a premium upon the penurious use of water.

The privilege of having a connection and being able to obtain water from a public supply on demand is valuable and should be paid for. The cost of reading meters, recording the same and rendering bills is a substantial cost and is practically uniform without regard to the size of the meter or the quantity of water taken. Further, there is no demand charge included in this form of rate, and certainly the water works is entitled to payment based upon the capacity of the consumer to demand service. As an example: A small manufacturing concern, such as a laundry requiring the delivery of large quantities of water in a limited time, must have a larger meter than a house. This class of consumer draws only for a few minutes at a time, nevertheless, requires a greater capacity of pumping machinery, filters and mains to meet this demand. The 2-inch meter on the supply to the laundry has the capacity of twenty ⅝-in. house meters, and therefore, equitably, it should pay 20 times the demand charge of the house.

The third schedule is the most scientific, in that it successfully divides the service rendered into the proper divisions:

1. The cost of reading the meters, recording, billing and accounting.

2. It places a demand charge on each consumer in proportion to his ability to demand water, and

3. It places a charge upon the consumer for the quantity of water taken, in accordance with a sliding scale based upon the actual quantity of water used.

Upon the granting of the franchise to the Water Company in 1903, the schedule was that of the old flat rate system, which was based upon a quarterly rendition of bills in advance of the service; that is, at the beginning of each quarter the consumer was billed for the water rate for the ensuing quarter based upon the number of fixtures, frontage and size of house. Very little or no complaint was made to the advance payment of the quarterly charge. Contracts were sup-

posed to be made for an entire year, and it was expected that the consumer would take water for twelve months.

There was a clause in the franchise which permitted a consumer on demand to purchase a meter and take water by meter rates, which were also prescribed, based upon the daily consumption in thousand gallons. A like privilege was granted the Water Company, in that if they suspected a party of wasting water, having poor plumbing or using it for other purposes than that contracted for, they had the privilege of installing a meter and charging for water at meter rates. The result of this schedule was that those people who were thoughtful, soon realized that they were taxed an excess amount to cover possible wastage and loss, and began to demand meters, more particularly the commercial concerns. At first there were few meters in use, and it was a simple matter for one man to go out and read these meters on the first of each month.

With large consumers of water such as railroad companies, with the possibility of stoppage of meters involving large pecuniary losses and causing argument as to the proper adjustment of bills, the practice of reading meters monthly was justified and is still followed.

This was the condition of affairs when the Commission took over the operation of the plant at the time of purchase by the City in 1917.

Abuses had grown up during these years of private ownership due to political conditions. Sixty per cent of the consumers were obtaining water through meters, some having yearly contracts, others monthly contracts. Those having yearly contracts were granted the privilege of offsetting high consumption during one period of the year against low consumption at another period. Those having monthly contracts were denied this privilege, which caused friction and discontent. The remaining 40 per cent of the consumers were being supplied under the old flat rate system of contract.

An analysis of the total water pumped and delivered to the distribution system and a systematic reading of the small meter supplying the metered consumers, showed that the 40 per cent of unmetered consumers were using over 60 per cent of the total water pumped. A census of the city, of the number of dwellings therein, showed that there were approximately 12,000 properties that should be consumers of water and of these 12,000 there were existing on the books only 6,500 consumers of water. How and where did the remaining 5,500 properties get their water supply? There were two sources, wells and cisterns which had been condemned by the Health Department as insanitary and likely to cause sickness and epidemics, and secondly, a surreptitious taking of water through the taps of neighboring properties. A large percentage of these properties not connected to the water works system were owned or at least occupied by the colored population.

The question of municipal ownership and operation was a doubtful experiment, and in my opinion our Commission wisely decided to disturb the customs and rates in force to the least possible extent, and therefore adopted our present schedule of rates. These, while not the most scientific, are equitable and just.

1. We discarded the yearly contract, feeling that it was not equitable, and if required, and not enforced, would grow into an abuse.

2. That a three months' contract was equitable and imposed no grievous hardship, should circumstances compel one to surrender his contract after a few weeks of service, as the minimum charge of $3 would not more than cover the cost of setting meter, removing same, reading and billing for a short period.

3. It would permit those people who spend the summers away from the city to close their houses, cancel their contracts and have the water shut off, thus eliminating the danger of high bills due to leaky plumbing during their absence. It further gave them the possibility of equalizing the low consumption during one month as against high consumption during another month of the same quarter.

The minimum rates provide an ample supply of water to cover all legitimate needs of the average family without offering a premium on a parsimonious use of this essential commodity. In other words, it is possible for the average family in the city of Charleston to have all the conveniences of modern plumbing, such as kitchen sink, toilet, bath room, basins and an ample supply of water for $3 a quarter; further, it places this service within the reach of the most humble citizen.

That this action on the part of the Commission was wise is evidenced from the satisfaction it has afforded. Consumers have increased from a little over 6,500

to over 9,000 in the five years of municipal ownership. The entire city has been metered, the amount of water accounted for has increased from 55% in 1917 to an average of 85% in 1921-1922. The difference is accounted for by the water used for municipal sewer flushing and fire purposes. This percentage of accounted for water is above the average of American cities, and is exceeded by a few only.

A Study of Monthly Reading and Billing

The only complaint that has been made against the schedule as adopted is the payment of high bills owing to defective or poor plumbing, and some of our citizens feel that if the Water Department should read meters and bill monthly, they could thereby check up and keep tab on the condition of their plumbing more accurately than if read quarterly.

A careful study of water bills justifies the sub-conscious deduction of our employees, that consumers pay little attention to their increasing water bills until they reach a very high percentage of the normal consumption, and even then do not take the necessary precaution to see that their plumbing is properly repaired, as is evidenced by a second and third period of abnormal consumption.

How much less attention will be paid to the increasing consumption when the readings are made monthly, and the increased increments therefore smaller? Further, a leak amounting to so little as 1 gal. per minute taking place in a yard toilet (usually installed for the convenience of servants, and therefore not directly under the observation of the thoughtful members of the family), will account for a bill of $10.50 in 30 days.

Using the information obtained in the study of bills, and assuming that $10 is a reasonable and not an exorbitant bill and that the arithmetical mean of these divisions represents the average amount of money involved in each bill, we find that the following bills were rendered in excess of $10 per quarter:

2,983	Bills rendered for avg. amt. of		$12.50
961	Bills rendered for avg. amt. of		17.50
382	Bills rendered for avg. amt. of		22.50
375	Bills rendered for avg. amt. of		37.50
64	Bills rend. not in excess of amt. of		75.00

Using the limit of a non-exorbitant bill as $10 per quarter, and the information on heavy consumption, together with the possibility of a small leak, as hereinbefore mentioned, it is a reasonable and fair conclusion that there would be no saving effected to consumers where their bills are only 150% in excess of $10 or $15 per quarter.

Again, assuming that every dollar in excess of this maximum bill of $15 could have been saved the consumer, we find the following:

2,983	Bills at an average of $12.50 less $15.00 max.	No saving.			No saving.
961	Bills at an average of 17.50 less 15.00 max.	Saving	$ 2.50		$ 2402.50
382	Bills at an average of 22.50 less 15.00 max.	Saving	7.50		2865.00
375	Bills at an average of 37.50 less 15.00 max.	Saving	22.50		8437.50
64	Bills at an average of 75.00 less 15.00 max.	Saving	60.00		3840.00
	A total saving during the three years and nine months of				$17,545.00
	An average annual saving of				$ 4,690.00

The above assumptions are certainly liberal and I feel that practically they cannot be obtained, owing to the frailties of human nature, and knowing how soon we lose sight of the newness of the "broom." However, the consumer is fully entitled to the benefit of the doubt in the case.

The next phase of the subject is, how much will it cost all of the consumers to effect this saving to one and fifty-four hundredths per cent of the consumer? Before proceeding to this portion of the discussion, let us consider some of the duties of the Commission to the public.

It is undoubtedly the duty of the Commission to operate the Water Works Plant efficiently:

1. As to the quality of the water.
   (a) For drinking and cooking purposes.
   (b) For laundry and general household use.
   (c) For manufacturing purposes.
2. As to quantity of water.
   (a) For sanitary purposes.
   (b) For fire protection.
3. As to extension of mains and conduits and plant to supply the growing needs of the city, (for without an adequate water supply no city can grow, however fortunately she may be otherwise situated and endowed).
4. Economically upon a business basis.
   (a) That the citizens may be taxed equitably and justly for the service rendered them and that none receive privileges not enjoyed by all.
   (b) That all moneys due be collected promptly and all purchases of material and supplies be honestly made at lowest obtainable prices, quality alone for service intended being considered.

(c) That all expenses of operation, maintenance, sinking fund, interest on bonded indebtedness or cost of plant be paid from the income collected and that any excess income above these expenses be set aside as a surplus out of which future extensions, improvements to plant and water supply facilities shall be made.

(d) To employ an efficient personnel to conduct the operations of the business with the least number of persons that there may be a minimum of inefficiency, soldiering, slackness and indifference.

It is well recognized that the most efficient organization is the one having the smallest personnel to accomplish the work with accuracy and dispatch. With our present system of quarterly reading, the work has been so systematized that each employee has a definite portion of the work to perform, and each is thoroughly acquainted with the work of the other members of the organization, with the result that there is thorough team work. There is a minimum number of units in each division of the work, and, therefore, the responsibility for error can be placed directly upon the one at fault. This has resulted in a very high degree of efficiency, and it will be necessary if monthly reading of meters is adopted, to increase the number of employees, with the consequent and inevitable loss in efficiency due to increased number.

Should we adopt monthly reading of meters, we estimate that it will require the following additional employees:

An assistant to the Contract and New Business Clerk,

Three additional Meter Readers,

Three additional Clerks in the Accounting Department,

One additional man for shutting off and turning on water.

Further, stationery supplies such as bill heads, delinquent notices, etc., will be increased three-fold.

The cost of postage for the delivery of bills will be increased three-fold.

The general expense in the office for ledger cards, addressograph plates and inter-department stationery will be increased three-fold; and to accomplish the work with the increased force, it will be necessary to install an a ddditional mechanical book-keeping machine.

We estimate the increased cost of this additional help and equipment as shown in the tabulation below.

It will be seen, therefore, that to effect a saving of $4,700 per annum to one and one-half per cent of our consumers, it will be necessary that all of the consumers spend a total of $12,540 per annum. Certainly an inefficient method of saving.

Of course, it will be argued by some, that as the Department is earning money in excess of its operating expenses, maintenance, depreciation and sinking fund, and as the property is owned by the public, this additional cost of reading meters monthly should not be considered. We contend that this is a false premise, and that it is the duty of the Commission to operate the plant efficiently for all, and that if 98½ per cent of the people are taxed a sum ever so small for the benefit of the 1½ per cent, then some are receiving special consideration.

The Department is endeavoring to help all consumers and to this extent reading meters and inspecting premises to aid and assist the consumers in locating their troubles. This service, however, instead of proving beneficial to the consumer, seems to be leading in an opposite direction in that requests for the re-reading of meters and inspection of premises for leaks are increasing, and further, some of the consumers seem to think that it is one of the duties of the Water Department to locate defective plumbing, and unless the Department can locate the cause of the high consumption of water, they take the position that it is the fault of the Department and they should be relieved of the excessive bill.

A record of the re-reading of meters during the past four months shows that 10% of the meters regularly read have been re-read on request of the consumer, and in addition thereto, over 400 inspections were made at the request of property holders to determine whether their

Item	Increased Cost
An Assistant to Contract and New Business Clerk	$ 150.00
Three additional Meter Readers	375.00
Three additional Clerks	220.00
Additional man for shutting off and turning on water	70.00
Stationery—additional bills	30.00
Postage—delivery of bills	120.00
Other stationery	65.00
Maintenance and depreciation of second billing machine	15.00
Increased cost per month	$1,045.00
Annual increased cost	$12,540.00

plumbing was leaking. This re-reading and inspection service is likely to become an abuse in that property holders do not take the ordinary precaution to watch the services and fixtures themselves.

The plumbing and fixtures of a house are a part of the consumer's property and should be taken care of and watched by him the same as any of the other manifold household operations. If care and prudence are not exercised the fixtures become a "thief in the night," or the same as a careless and wasteful servant.

The meter is a comparatively simple device and as installed is readily accessible and easily read, and an inspection of the meter by the householder will readily determine whether leaks exist. Upon the development of a leak the remedy is to employ a plumber to repair the plumbing and after he has done his work it is a very simple matter to test out the thoroughness of his work by watching the meter for a few moments when no water is being drawn from any of the fixtures.

The matter of leaking fixtures and service pipes was aptly expressed by our mayor in his address to our aldermen as follows: "The duty, therefore, is put up to the individual to watch his fixtures and see that there are no leaks, just as the individual is supposed to do wtih his health."

In an effort to determine the custom as to meter reading interval, a questionnaire was mailed to 32 cities located in the southeastern portion of the United States and replies were received from 21 including ourselves. Similar information was obtained and tabulated from the annual reports of 12 northern cities.

It was shown from the information received from the southern cities that monthly and quarterly reading of meters are about equally divided, a slight preponderance are at present using monthly readings. Some of the managers who are now reading monthly prefer quarterly reading and some who are now reading quarterly, prefer monthly reading. The northern cities seem to prefer quarterly reading almost unanimously. One city reads semi-annually and bills annually.

We are very much of the opinion that the question of reading meters, as adopted by any community, is more one of custom than otherwise, but where the matter has been gone into with a view of obtaining the most economical operation of the entire system that the reading of meters oftener than quarterly is inefficient and expensive.

In summarizing the arguments for and against monthly reading and billing we have:

Argument in Favor of Monthly Reading

1. Possibility of an estimated saving of $4,700 per annum to consumers.

2. Possibility of catching a leak before the amount of the bill has reached an exorbitant or excessive charge.

3. The possibility of enabling an individual property holder to check up on the condition of his plumbing.

Argument Against Monthly Reading

1. Increased cost to the department of $12,500 per annum.

2. The above expenditure protects less than 2 per cent of the whole at the expense of all.

3. Increased number of employees and office force with lowered efficiency.

4. Increased probability of error, with increased number of requests and complaints from consumers for re-reading.

5. Increased complaints as to frequency of bills and requests that bills be sent not oftener than once a quarter, causing confusion in office routine.

6. Increased complaints of consumers on account of receipt of delinquent notices and the shutting off of water in case of nonpayment of bills.

7. Increase in complaints due to the short period which consumers will have to average up their high or peak consumption. (With quarterly readings, we now have a number of requests that consumers be allowed to make up their excess bills accruing one quarter with deficiencies of the past quarter.)

8. Will necessitate a revision of our rules and regulations which have been fairly well established and understood during the past five years of operation.

9. Reduces the credit extended consumers. (At present a consumer has an average credit of approximately 60 days, whereas with monthly reading this would have to be abolished and bills would necessarily have to be paid not later than the 15th of each month.)

10. Would be a change of custom without a definite assurance of any improvement.

That the quarterly reading of meters and billing for water used has met the requirements of efficient management goes without saying, as is evidenced by the five years of successful operation at Charleston. We passed through the trying time of the world war without an

increase in rates for water service when many other water departments throughout the country were forced to raise their rates and issue bonds for increased facilities. We have not only met all of these conditions, but also have brought the plant from a run-down, inefficient condition to a state of high efficiency, making many necessary and permanent improvements, so that today we have a water works system in which every citizen can take pride.

We are not averse to changes if they show a possibility of improvement. We are, however, firm believers in conservatism, especially in the matter of the municipal operation of a water works system, and feel that the public should rely upon the business ability and good judgment of their commission as to the best business policy and the management of the water department.

The foregoing matter is from a paper presented by Mr. Gibson before the recent convention of the Tri-State Water and Light Association at Birmingham, Ala.

PRACTICAL RANGES IN LOAD FACTORS FOR WATER PURIFICATION PLANTS

(Editor's Note—Following is the full text of the report of the Committee of the American Water Works Association on Practical Ranges in Load Factors for Purification Plants. Mr. Edward E. Wall, Water Commissioner of the city of St. Louis, Mo., was chairman of the committee.)

In May, 1921, a questionnaire was sent out to a large number of filter plants throughout the country by the members of the committee, which brought to them a great quantity of information, most of which, however, was of little value for the purposes of the committee, on account of the great majority of plants being operated under average conditions and treating waters not relatively high in pollution. The data collected from each plant showed so much variation from time to time because of prevailing conditions (e. g., the variations in quality of the raw water, such as turbidity, fineness of suspended matter, color, hardness, temperature and bacterial content, quantity of water treated, length of time for coagulation and sedimentation, rate of filtration, etc.), that it seemed an interminable and hopeless task to attempt to determine limits for purification modified by minimum or maximum requirements of these numerous variables. It was the intention of the committee to select from the list of plants answering the questionnaire, those operated by experienced men, and dealing with raw waters having rather a wide range in their objectionable qualities, for close observation and study.

This did not prove to be entirely practicable when the information received from numerous places was tabulated, because of the great variation in the character of purification plants, the diversity of the methods used and the degree of skill exercised in their operation, not to mention the wide range in the characteristics of the waters treated, so that the selection of distinctive plants was not so easy as had been at first imagined.

To illustrate this, and also to give an idea of the ranges in the qualities of the raw waters and the variations in treatment and operation, Table I, summarizing results, has been prepared.

An examination of the individual reports reveals the fact that many plants deal with raw water varying in one or more of the objectionable characteristics from the maximum to the minimum shown in the table, and are reported as obtaining satisfactory results. This may be interpreted as meaning that the consumers in those localities, having always been accustomed to the local water supply, have become resigned to it, believing that no further improvement is necessary or can be made. The committee has no way of finding out where this is the case, as only at a few places are complete and thorough analyses made frequently enough to supply the information necessary to establish the real quality of the water supplied to these communities.

The figures set out in the table give but an imperfect idea of the difficulty of attempting to classify purification plants according to the quality of the raw water treated. Leaving out of consideration the wide variance in methods of treatment, there still remains for study the great difference between the surface waters east of the Alleghanies and those of the Mississippi river valley, as well as the variations in the individual waters of any district of considerable area.

Illinois

For example, of the 19 plants in Illinois summarized in the table, none of them take their supply from Lake Michigan, but from streams, the waters of which would naturally be supposed to be very similar in character. Now, as to the

loadings on these plants, the maximum turbidity reported at any one plant is 15,000; two plants report maxima of 10,000; one reports 8,000, and several 2,500. Two plants report average turbidities of about 500, two others from 250 to 300, and four from 100 to 150.

The maximum color reported is 250; two plants report 70, four give maxima of 50 and seven state their highest figures from 30 to 40. The highest average color reported is 54, two plants give averages of about 35, four others from 25 to 30, and five from 15 to 20.

The maximum bacterial count is 90,000, the next 50,000, three others report 18,000 to 24,000 and two plants 8,500. The highest average is 3,600, two plants have 2,100, two others 1,250 and 1,750, respectively, and four from 400 to 800.

Two places report gas-forming organisms present in all one-tenth c. c. samples of raw water, two others find positive results only in a majority of one-tenth c. c. samples. Eleven plants report that 10 c. c. samples of raw water always show positive results and that one c. c. sample in most cases also analyze as positive. Three places report nine-tenths, three others three-fourths, and four that one-half of the one-tenth c. c. samples show positive results.

All of these plants are reported to purify successfully these waters, which vary so greatly in their objectionable qualities, but it is likely also that there is just as great a variation in the quantities of chemicals used and in the wash water and chlorine necessary to produce safe effluents.

Information on the Illinois purification plants was supplied to the committee by Mr. Harry F. Ferguson, Chief Sanitary Engineer of the State Department of Public Health, who has very generously agreed to digest the present available analytical data along the lines decided upon by the committee and to arrange for additional and more complete analytical data in the future from plants dealing with highly polluted or difficult waters.

There are not many water purification plants in Missouri, and information has been received from only five places, at none of which is there any indication of overloading, nor do any of them deal with waters carrying a high degree of pollution. This is true of all the plants in several other states, for example, Iowa, Minnesota, Wisconsin, North and South Dakota, from which the committee has received data. Inquiries as to whether the communities in these states are satisfied with the water supplied them are invariably answered in the affirmative. Requests for health statistics on water-borne diseases have been barren of results, principally because no reliable records seem to be available. All of these plants seem to be operating without changes in the methods of treatment, year after year, so that apparently the raw water is not getting appreciably worse.

Virginia

There are 52 filtration plants in Virginia, of which one is of the slow sand type, and four are primarily for water softening. None of the raw waters treated are very badly polluted and the turbidities seldom exceed 2,000 or 3,000 and then only for short periods. Very little data is available as to what should be considered excessive loads for the several processes, such as coagulation basins, filters and sterilization. Practically all of them are being operated without serious difficulty and the loads on basins and filters are well within the range as to what should be considered permissible. Only eight of these plants have laboratory facilities at the works, and these may be classified with regard to the kind of water treated, as follows:

No.	Tot. Cap. m.g.d.	Classification.
3	48	Primarily for color removal. Bacterial pollution negligible.
1	6	Treating impounded supply slightly turbid at times. Bacterial pollution negligible.
2	8	Bacteria (37 deg. count) seldom above 1,000 per c. c. Turbidity usually below 600.
1	28	Bacterial (37 deg. count) from 500 to 3,000 per c. c. and turbidity usually below 1,000. Only partial laboratory data available.
1	30	Richmond plant, filtration contemplated.

TABLE I—DATA ON WATER PURIFICATION CONDITIONS AND PRACTICE.

State	No. of Plants	Type of Plant	Raw Water Turbidity Max.	Turbidity Min.	Color Max.	Color Min.	Bact. Per c.c. Max.	Bact. Per c.c. Min.	B-Colo Per 100 c.c. Average
Pennsylvania	6	Rapid Sand	6,000	2	500	5	17,000	5	15 to 1,000
New York	6	Rapid Sand	6,000	13	180	6	100,000	14	15 to 340
New Jersey	3	Rapid Sand	1,000	5	150	5	2,400	0	.....
Missouri	5	Rapid Sand	5,000	5	35	3	113,000	15	22 to 90
Illinois	19	Rapid Sand	15,000	5	250	8	90,000	40	20 to 520
Pennsylvania	5	Slow Sand	4,500	2	40	5	1,200,000	110	75
New York	3	Slow Sand	600	3	62	15	48,000	10	1,000 to 13,000

From studies on the above plants, and also observations at the smaller plants, Mr. Richard Messer, Chief Engineer of the State Board of Health of Virginia, and a member of this committee, draws the following tentative conclusions:

Coagulation Basins—(a) For colored waters the period should be at least 6 hours and preferably longer, up to 10 or 12 hours.

(b) For turbid waters the period should be at least 3 hours. However, a longer period serves as an extra safeguard at times of sudden fluctuations in the character of the raw water.

(c) The velocity of flow through the basin should not exceed 0.75 ft. per minute and in the last half of the basin the velocity of not over 0.4 ft. per minute is desirable.

Coagulation—Regulation of the application of chemicals to obtain the optimum coagulation is a matter of prime importance. When the optimum coagulation is obtained the floc which goes into the filters will be of such quality as to maintain maximum efficiency of the filtration process, provided the floc is not broken up while being conveyed from the basin to the filters. If the application of chemicals is not correct the suspended matter carried onto the filters will be of such a character as to penetrate deep into the sand and eventually pass all the way through. Except as to the amount of wash water required it does not make so much difference as to the quantity of floc carried onto the filters but the quality is of prime importance.

Filter Sand—For filtering waters in this state, the sand should have an effective size of between 0.35 and 0.45 mm. and a uniformity coefficient of not greater than 1.6. Not more than 10 per cent by weight shall be coarser than 0.9 mm.

Filter Gravel—The depth of gravel shall be not less than 18 ins. and preferably 20 to 21 ins. The gravel shall be graded and placed carefully and the thickness of layers shall vary directly as the size; i. e. the greatest depth to consist of the 2½ to 1 in. size and the thickness of layers decreasing up to the surface layer.

Washing—For effective washing the rise should not be less than 18 ins. per minute and preferably 24 ins. per minute, but not greater. It is very important that the rate shall be uniform over the entire bed.

Chlorination—Provision should always be made for sterilizing the filtered effluent with chlorine as a secondary safeguard.

In some instances chlorination alone may be relied upon, provided the supply to be treated is practically free from turbidity at all times and provided further, that the sanitary survey shows that there is only a remote possibility of sewage getting into the supply but where the origin of the B. Coli content cannot be ascertained.

Northeastern States

The waters treated in the northeastern states, Pennsylvania, New York, New Jersey, etc., are in many cases highly polluted, so that it is a far more promising field for study for the purposes of this committee than can be found in the southern and western states.

Mr. S. M. Van Loan, Deputy Director of the Bureau of Water in Philadelphia and a member of this committee, has collected a mass of data from these states, but like the other members of the committee, has met with great difficulty in obtaining precise and definite information on points of special interest to supplement data given in the first reports. In many cases members of the committee have been greatly disappointed in receiving no replies at all to questionnaires sent out, and especially from plants known to be treating difficult waters.

Mr. Van Loan goes on to say that due recognition is given to the fact that at certain plants, methods of keeping records are widely different and a questionnaire might not at all times adapt itself for furnishing the information desired. Also, that one feature that has injected a degree of uncertainty in analyzing plant results is the method used in determining bacteria counts, and until the Council

TABLE I—CONTINUED.

Treatment of Water Before Filtration.	Rate of Filtration Per Acre	Time in Hours Bet. Washings	Chemicals Used.
Aeration, Coag. & Sed.	80 to 176	3 to 50	Alum, Iron, Soda Ash & Chlor
Coagulation & Sedimentation	120 to 181	4 to 24	Alum, Chlorine & Cop. Sulp.
Coagulation & Sedimentation	62 to 200	8 to 60	Alum
Coagulation & Sedimentation	62 to 125	10 to 171	Alum, Lime & Iron
Aeration, Coag. & Sed.	50 to 175.	6 to 72	Alum, Lime & Soda Ash
Sed., Aeration & Pre-filtration	2 to 10	.....	Alum, Lime & Chlorine
Coag., Sed. & Prefiltration	3	.....	Alum & Chlorine

on Standardization has set a standard, which will be used generally throughout the country, there can be no consistent comparison made on the various plant results. He suggests that a standard form for reporting filter operation should be adopted.

Ohio

Following his appointment on the Committee of the American Water Works Association on Practicable Loadings for Purification Processes in 1920, Mr. F. H. Waring, Principal Assistant Engineer, Ohio State Department of Health, organized the Ohio Conference on Water Purification in November, 1921, comprising the men actually employed in charge of water purification plant operation in the state of Ohio. Ohio has 62 water purification plants serving 32 cities, 23 villages and 7 unincorporated communities. The total population thus served is 2,561,000 as of the 1920 census. A practically complete representation was obtained at meetings held in Columbus in November, 1921, and November, 1922.

At the 1921 meeting questions were put to the Ohio filter plant superintendents, these questions involving research study upon loading of water purification processes. The writer selected 10 filter plants for conducting of the special studies. The selection was based on an accurate knowledge of the peculiarities of the water purification plant, the raw water, and the fact that these plants were in charge of experts trained and experienced in water purification and control. The variety of conditions encountered is indicated as follows: Akron, a 30 million gallon plant taking water from a large impounding reservoir on Cuyahoga River; Cincinnati, a 112 million gallon plant taking water from Ohio River directly; Cleveland, a 150 million gallon plant taking water from Lake Erie; Ironton, a 4 million gallon plant taking water from Ohio River directly; Lima, an 8 million gallon plant using as a source of supply a large artificial lake receiving intermittent pumpage from Ottawa River; Portsmouth, an 8 million gallon plant taking water from Ohio River directly; Sandusky, a 10 million gallon plant using as a source of supply Sandusky Bay of Lake Erie; Steubenville, a 6 million gallon plant using Ohio River as a source of supply; Toledo, a 56 million gallon plant using Maumee River as a source of supply; Warren, an 8 million gallon plant using Mahoning River as a source of supply. In addition to the above, three plants having water softening features were selected, Columbus, a 54 million gallon plant using a large impounded reservoir on Scioto River; Defiance, a 2 million gallon plant using Maumee River directly; Youngstown, a 28 million gallon plant using Mahoning River as a source of supply.

The foregoing selection served to cover the range of raw waters in this State varying from the least polluted and cleanest source of supply (Lake Erie at Cleveland) to the most intensely polluted and otherwise objectionable source of supply (Mahoning River at Youngstown).

In order to make comparisons of the several plants the 1921 conference standardized the procedure for reporting; for laboratory practice, and quality of the filter effluent both before and after chlorination. In several instances it was possible to utilize previous data collected, but for most plants work was initiated. The 1922 conference held at Columbus in November took up the topics assigned previously, each of the ten regular filter plants reporting upon the studies and each superintendent offering opinions in answer to the questions. Certain of the topics have been held over for further study and certain new questions were raised. The complete discussions of these topics and including original papers of great value prepared by some of the men are now being compiled for publication in a special bulletin of some 125 pages to be published by the Ohio State Department of Health.

There will be available for the committee the results of investigations into the stream flow, the pollution and the self-purification of the Illinois River, conducted by the U. S. Public Health Service, and of a similar investigation on the Kansas River and its tributaries conducted by the State Board of Health of Kansas, whose Chief Engineer, Mr. Albert H. Jewell, writes that on account of the mass of data to be digested, no information of value to the committee can be given at present.

Stream Pollution and Self-Purification.

The determination of the practicable loads for purification processes leads directly to consideration of the pollution of sources of water supplies and the self-purification of streams and impounded polluted water, so that study of these subjects must perforce become a part of the committee's work. Even if it were possible to develop the science of water purification to the point where water fit

for human consumption could be produced from the very worst polluted sources, the item of cost, if nothing else, would set a limit beyond which it would be impracticable to go,— that is, there would always be a point where the cost of treatment would mount up to such a figure that the prevention of pollution would be cheaper and more practicable than purification.

In this connection, Mr. H. W. Streeter, Sanitary Engineer of the U. S. Public Health Service, writes from Cincinnati:

"In connection with stream pollution investigations being conducted by the U. S. Public Health Service, consideration is being given to a proposed extension of a preliminary study of filter plant loading factors made by this service a few years ago, the results of which were briefly summarized in a paper, 'The Loading of Filter Plants,' appearing in the March, 1922, issue of the Journal of the American Water Works Association.

"Consideration has thus far been given to two possible lines of study of the problem, one consisting of a field survey of a selected group of plants in routine operation, and the other an experimental study of loading factors under controlled conditions, using for this purpose an experimental plant to be built for the purpose, somewhat similar to those which were recently operated at Milwaukee and Detroit, but located on the Ohio River at Cincinnati, which is our headquarters. We have thought of the latter kind of a study as permitting us to observe purification efficiencies under conditions approaching or even surpassing overload without incurring the dangers to water consumers such as would be the case if experiments of the kind were to be attempted at a regular plant.

"The experimental method would permit us, moreover, to adjust arbitrarily and measure accurately the various complex factors that modify purification efficiencies under different conditions; likewise to determine under controlled conditions whether any definite law underlies the reaction of water purification processes to different degrees of loading. Enlightened on these points, we could then test their generality by field survey data and greatly clarify the main objective to be sought in such a survey."

The committee is much interested in Mr. Streeter's project and will follow closely the establishment and work of this experimental plant, co-operating with him in every possible way.

Although it may seem that the committee has little to show for the work of almost two years of its existence, in truth a great deal of work has been done in collecting information, finding out what sort of facts can be obtained and used, in determining the general course of investigation, and obtaining assistance from and co-operation with individuals and with public and private organizations.

The committee has also come to a full realization of the formidable task before it, the many directions in which its inquiries must lead, and the great variety of perplexing problems resulting.

The individual members of the committee are, to a certain extent, working independently of each other, each one following largely his own ideas as to how information should be obtained and digested. Then each member will send to the chairman a statement of conditions and results as he finds them, together with his opinions and conclusions. The chairman will broadcast them to the rest of the committee and to such others as are assisting the committee, and will eventually combine all these reports into one general committee report.

As has been heretofore stated, satisfactory service to the people served, and vital statistics not below the average for such places, must be considered conclusive evidence that water purification there is efficient. The loads upon these plants, if unusual, may serve to mark the approach to limitations in general. Any plant may for a short time be taxed to the full extent of its capacity and require all the ingenuity of its superintendent and chemist, together with a liberal use of chemicals, to deliver a potable and safe water under these extreme conditions, but this load could hardly be taken as the limit for similar purification plants, for at least two reasons, first, because it is extremely improbable that any other plant could encounter even approximately the same conditions, and second, because the peak load under which the plant was able to stand up for a short time was an overload and beyond its working limit.

A general standard may be set for a safe water for domestic use, just as that established by the U. S. Treasury Department for waters used by common carriers, but any attempt to place a limit on color, hardness, taste, odor, etc., would seem to be futile, since those characteristics vary with localities, where each community sets up its own standards.

FUNCTION OF STREETS AND HIGHWAYS IN NATIONAL TRANSPORTATION

By J. Rowland Bibbins, Engineer, 921 Fifteenth St., N. W., Washington, D. C.

The following is not an attempt to present a finished analysis of the present complex transportation situation but rather to mobilize some outstanding facts which have an important bearing upon the development of a national transportation policy in which the various agencies can play their proportionate parts most efficiently. Certain conclusions are stated, however, for the purpose of concentrating discussion where it is most needed. It is worth noting that no organization or association, national or otherwise, has as yet given to the whole subject of transportation the well-balanced and detailed study which is most urgently needed to meet the oncoming demand for adequate transport facilities.

Recent literature is replete with pronouncements of a general nature, but the time has come for specific action and the most fundamental changes in the policy of various transport agencies have already begun. The time is ripe for concerted action based upon reasonable interpretation of facts before, rather than after, broad national policies are enunciated.

How fast we are moving is evidenced by the fact that the Transportation Act, 1920,—our bible—does not definitely visualize to the slightest extent the function of highways or highway transport in our future system, nor does it recognize that the function of transportation begins with the origin of shipment and ends at the final destination of a consignment, including land, rail, water, terminal, collection and delivery movement. Station to station movement by rail is only one part of the operation and represents, perhaps, only one-half of the total cost to the consuming public.

Even the Agricultural Inquiry of 1921, while revealing an immense body of new data regarding the inefficiencies of distribution, did not give an adequate picture of the need of correlating the various transportation functions, especially highways and waterways. Perhops the broader view was too new and too big to permit of any other treatment at the time.

The important thing now is to recognize where transportation inefficiency exists and move toward its correction. Otherwise the problem of keeping up with our tremendous transportation demand will become increasingly burdensome. The review of the problem, as herein presented, is purposely comprehensive in scope. It rests with the various national organizations and technical bodies to develop practical ways and means for perfecting facilities and operations at the various points in the transportation journey where this increased efficiency would insure the greatest improvement in transit with the least drain on the capital resources of the country.

Some Pertinent Transportation Facts Reasonably Well Established

1. *Cost*: Our second industry, next to agrgiculture. To build it has cost about 50 billions net; 2-5 equals railroads; 2-5 equals highways and highway transport; 1-5 equals balance: marine, waterways, port facilities and electric railways. Total equals 1,200 dollars per worker. Probably half railroad investment, or 10 billion, is in other than main line track—terminals largely.

2. *Growth*: Cost has doubled in a decade. Railroad cost doubled in 20 years. Highways, nearly four times in 20 years, last doubled in four years. Railroad cost increased proportional to square of population; all transportation nearly as the 5th power of population.

3. *Capitol Input*: About 23 billions last decade; 2.3 billion average, per year. Highway ,16 billions; railroads, 4 billions; ratio, 4.1. Previous decade, 1.4.

4. *Freight Traffic*: Basic railroad revenue tonnage has increased steadily and consistently since the Civil War, not far from the cube of population. City population in the per cent of total is increasing; hence terminal traffic and operations are increasing, probably faster than the cube. Trucking tonnage must bear about the same relation, for all railroad freight (except that which moves car load direct) passes over streets, roads and highways one or more times, according to number of fabrications involved. Ton mileage is increasing faster than the cube of the population, due to increasing length of average haul.

5. *Present Traffic Indications*: A new high record in 1922-23. Present traffic running ahead of all expectations, C. L. and L. C. L. and commodities, now loading nearly one million carloads per week, the previous high peak record.

6. *The Next Twenty Years*: Estimated

population of 130 million people. A revenue tonnage of nearly 4 billion tons and between 800 and 900 billion ton-miles must be provided for. At least 25 billion of new capital is needed for all transportation, assuming all growth is *only as fast* as railroads. Also an additional 25 billion for replacements of worn out property.

7. *Operating Cost to the Public*: Probably 15 billion at present or an addition to the family budget of 275 dollars per worker per year. Transport cost of hauling tonnage to and from rails, probably equal to cost of rail haul, i. e., 4.5 to 5 billion per year.

8. *Growth of Facilities*: Rail mileage is increasing about as fast as population; freight cars as fast as tonnage; locomotive tractive effort as fast as the ton mileage. Increase of capacity of standard surface freight facilities, station team tracks, docks and wharves, is about proportional to lineal feet of extensions; also streets and highways, either single or two level, only in proportion to number of additional traffic ways provided.

10. *Highway Transport*: Gross motor registration in U. S., now over 12 million, has doubled 10 times since 1900, last doubled in 4 years. Estimated that nearly 30 per cent of vehicles are on farms. One and one-third millions trucks with rated capacity of 1 2-3 million tons. Estimated they carry nearly as much tonnage as the railroads with their 100 million tons car capacity. Connecticut road tests report 32 per cent of passengers carried for business purposes; motor production now maximum, 346,000 cars for March, 1923, over 2½ millions cars in year 1922. It is estimated that 1,800,000 are needed for replacement. Truck capacity average 1.2 tons ; 83 per cent 1 ton or under, 2.9 per cent 5 tons or over.

11. *Motor Taxation*: 1922 state taxes 216 million, equal total spent on federal aid roads. Total taxes 335 million exceeds total taxes paid by all the railroads combined.

12. *Road Building*:

"Improved Roads"	350,000 mi.
Primary system completed	71,500 mi.
Secondary system	98,000 mi.
Federal Aid roads under construction	19,187 mi.
Total road mileage	2,800,000 mi.

13. *City Land Values*: Increasing between 1.7 power and square of population. This purchasing power of cities for public improvements, independent of private capital. Terminal land values probably much faster.

Conclusions on a Transportation Program

1. Steady growth of transportation demand and limited new capital supply renders imperative the maximum use of and efficiency from all carriers, rail and road. Both are equally responsible for the cost of consumed products of soil or factory. Water carriers also share this responsibility.

2. Terminal evolution in the transportion gateways and large centers offers the greatest hope of maximum increased capacity with minimum investment, in which rail, motor, ship, barge and trolley must each play its part.

3. More movement, not more cars, is the great need, quicker turn around for car, ship, barge and motor. The cost of idleness is often greater than that of movement, in a peak load business, such as transportation.

4. Organize, consolidate and plan "off-rail" movement, so as to reduce wastes and delays in haulage, needless multiplication of part-used facilities and resulting fixed charges of idleness.

5. Organized contract delivery in the cities, and motor haulage in the country can not fail to reduce the cost burden of transportation to the consumer, the glutting of railroad terminals and increase the price received by the producer through reduced price spread.

6. Rail systems, both steam and electric, should have the prior right of and be encouraged in adopting motor transport where economically justifiable to avoid needless dissipation of investment and insure lowest combined transport costs. The contract agency plan appears entirely feasible.

7. Scientific research is rapidly determining the economic length of haul of roads vs. rail. We should accept the result and reorganize short haul movement accordingly.

8. Better cost accounting is an imperative need, the only sure road to knowledge of true construction and operating costs, or profits and losses. Visionary profits mean dissipation of capital in the end. This applies equally to railroad terminal operations for which there is now no official accounting standard.

9. Highway transport should be regarded as a complete business, including both roadway and vehicles and should

carry its own burdens—Pay-As-You-Use. But there is no justification in adding the burdens of a future generation to those of the present.

10. The fair principle of proportional distribution of costs with benefits in highway development is by no means yet accepted, but it is bound to come and careful economic research is awaited to establish the basic facts.

11. Inland waterways will find their economic level, if permitted to develop without undue restraint. Their possibilities as trunk-line carriers in rail-water hauls, both lake and river, have not been realized. Nor have the proper distribution of costs and benefits of waterway improvement been though out fully. It is the same problem as of the highways.

12. The serious problem of city and traffic growth has emphasized the necessity of decentralization, spreading our industries, developing our smaller communities. Local feeder roads, while also important in the general scheme, can not fulfill the entire need.

13. Entrance and by-pass city thoroughfares are, perhaps, the most important major traffic controls of the future. Little appears to have been accomplished in this field.

14. Street and roadway capacity is the key to the future. Usually depends on the number of effective traffic-ways rather than gross street width. Arcading narrow city streets may have to come as the only quick relief possible.

15. Developments of strategic railroad entrances for rapid transit and motorways offers great hope for reducing future transport investment and realizing upon the immense values of existing rights of way.

16. Rise in terminal land values must eventually force more intensive development or recession of freight and possibly passenger facilities with motor delivery.

17. Motorizing terminal service may become the best and only interim measure to develop needed capacity, at least capital cost, to realize the immense terminal land values. And this may be the means of leading away from the embarrassing problem of terminal "absorptions," the crux of the railroad rate problem.

18. Use and support of public streets and highways has now become an essential part of the whole transport plan. The public must now determine whether its own best interests lie in competition or co-ordination; taxation or subsidy; whether such use is in public or private interest. Discrimination will likely ensue unless the policy is broadly conceived.

19. The "twilight zone" of cheap property, surrounding the central district of our cities, can find a new use for organized in-town storage of business cars, a necessity if limited parking is to be enforced justly.

20. Metropolitan District Planning, 5, 10, 20 years ahead is today one of the greatest public needs in transportation, to avoid confusion existing among small regional communities and serious delays in public improvement. It may offer the best practicable substitute for "Home Rule." The transportation plan involves streets, railroads, terminals, transit, port and warehousing systems, all co-ordinated with the general city plan, i. e., zoning and other matters of public interest and welfare.

21. The terminal system, rail, transit, street and motor needs first study. For our traffic, in proportion to population, is growing by multiplication; our facilities by addition, if at all. Temporary expedients are only "paregoric;" a fundamental cure must be found and found soon.

22. That integration of the operating elements of a transport system must be brought about in the public interest even prior to actual consolidation is set forth in the New England Rate Division case, recently decided. By the same token terminal unification, in its broadest sense, is an equal duty.

The foregoing paper by Mr. Bibbins was presented before the recent annual meeting of the National Highway Traffic Association.

THE POSSIBILITIES IN INLAND WATERWAY DEVELOPMENT

By C. A. Newton, Representative in Congress from Missouri, in Address Before U. S. Chamber of Commerce

The greatest question before the country today is the solution of the transportation problem. What will be solution be? Will it be the building of more railway lines and more equipment? If so, who is to furnish funds? Do you know of any capital in this country seeking investment in railway securities? If capital will not invest in railway securities, shall we undertake, from the public treasury,

to supply the necessary funds and embark on another era of government operation? By experience we have learned the cost of such an undertaking. Why not adopt a national policy of assisting the railroads by developing and using other methods of transportation, especially if such other methods can produce a cheaper service?

We have expended in this country during the past four years, through federal and state appropriation, a sum in excess of $2,000,000,000 for the improvement of our highways. These highways are making it possible to gather our products from the fields, the factories, the mills and the mines, and to assemble them along the great rail lines of the country, but the rail lines are annually becoming less able to distribute these products as the commerce of the nation demands.

We have in this country great natural trunk line waterways. They penetrate our great industrial and agricultural districts; they flow by the gates of our cities where industry is being retarded by lack of facilities for transportation, and thence they flow out to the sea. Today they are rolling idly through our valleys, contributing nothing toward the nation's wealth. Why not improve them and use them? Why not make them a part of a great transportation system composed of highways, railways and waterways, not engaged in destructive and wasteful competition, but co-ordinated and co-operating with each other?

Is Waterway Development Practicable?

First of all, is the development of our waterways practicable? Can they be made of any real assistance to the railways and highways in carrying the commerce of the country? Can they be made a part of a great system of transportation capable of meeting the demands of commerce?

I know of no better answer to these questions than a study of the results of the Government's experiment upon the Mississippi River. As you are doubtless aware, the War Department is operating a barge line upon the Mississippi between St. Louis and New Orleans. Its equipment consists of 39 barges and 8 towboats.

That operation has been handicapped by the failure of Congress to provide sufficient funds with which to improve the Mississippi River between Cairo and St. Louis. It has been further handicapped by the lack of sufficient equipment to reduce the overhead expenses and to insure an economical operation. This operation has been further handicapped by the lack of adequate facilities and by the lack of co-operation on the part of the railroads.

Unfair Rail Rates

The barge line has been further handicapped by rail rates upon lines paralleling the river. For illustration: The rail rate on 100 lbs. of sugar from New Orleans to St. Louis—718 miles— is $1.55½, while the rail rate upon 100 lbs. of sugar from New Orleans to Fort Smith, Ark.,—494 miles—little more than one-half of the distance but off the river, is $1.94½, and the barge line is permitted to charge only 80 per cent of the rail which parallels the river.

Another handicap with which the barge line has had to contend has been the division of freight between the rail and water lines. For illustration: The joint rail and water rate, per 100 lbs. upon first class freight between St. Louis and Bayless, Ark., is $1.55½. The railroad hauls the freight 74 miles and takes 88½ cts. of the freight. The barge line hauls the same freight 306 miles and gets 67 cts. of the freight. Upon the same class of freight from St. Louis to Monroe, La., the railroad haul is 239 miles, and it takes 48 cts. of the freight collected. The barge line haul is 408 miles, and it receives only 35 cts. for its service.

These instances might be multiplied, but it is interesting to note that in the face of all these handicaps, the barge line has operated successfully and has yielded a profit to the Government. As a fair illustration of this operation, the Mississippi Barge Line during the first six months of last year carried 430,533 tons of freight, for which service the shippers paid $1,641,990.11. The total expenses of the barge line operation during this period amounted to $1,289,224.01, leaving a profit to the Government during the six-month period amounting to $352,776.10, which was enough to pay the depreciation upon the reproduction cost of the entire equipment and to earn on an annual basis 7½ per cent upon the investment.

The barge line earned this profit carrying freight at 3.05 mills per ton mile, while the average rail rate of the country, as shown by the records of the Interstate Commerce Commission, was 10.76 mills per ton mile. True, the distance from New Orleans to St. Louis is one-

third greater by barge than it is by rail, but even considering the barge rate upon the rail distance, the barge line earned a profit in the face of all the handicaps which I have enumerated, and carried freight at less than 50 per cent of the average rail rate of the country. This successful experiment under government operation should be sufficient to remove the last lingering doubt in the most sceptical mind as to the practicability and benefit to the shipper of the improvement and use of our inland waterways.

A striking argument in favor of the improvement of our inland waterways and their use as a part of the transportation system of the country, and their potentiality as a part of that system in supplying facilities for transportation adequate to meet the needs of our commerce, will be appreciated when I tell you that one towboat with its fleet of barges makes the trip from St. Louis to New Orleans in a period of 6 days, carrying enough freight to load 12 full freight trains with 50 cars to each train and 50,000 lbs. to each car. One towboat with a fleet of six barges loaded with steel made the trip within the last month from Pittsburg to Cairo in a period of eight days. Three of those barges were taken to St. Louis with steel, which was transferred to railroad cars at St. Louis, destined for the oil fields of Wyoming. These three barges alone, constituting one-half of the fleet, carried enough to load 300 freight cars; and the shipper upon these three barges alone, in the difference between the cost of transporting this steel by water from Pittsburgh to St. Louis and the rate which the rail lines would have charged for the same service, saved in excess of $7,000.

Shippers in every congressional district in Ohio, Indiana, Michigan, Illinois, Missouri, Iowa, Nebraska, South Dakota, Wisconsin and practically all of the congressional districts in the southern portion of the Mississippi Valley, were patrons of this line.

The Demand for Lower Freight Rates

A question which is rapidly becoming a burning issue in this country is a demand for cheaper rates for carrying our freight. I am not one of those who believe that the railroads can make substantial reductions. I believe that they are doing their best to economize and reduce rates. I do not believe that they are making excessive profits, and I am sure that their income in not sufficient to enable them to pay a reasonable return to the investor who contributed the funds for their construction.

If the railroads are unable to afford cheaper transportation, why should not the shipping public be permitted to enjoy the benefits of cheap water transportation where such transportation can be made available? And then, as a matter of justice and good public policy, the railways should be permitted to charge a compensatory rate—a rate sufficient to maintain their equipment, defray their expenses and pay a reasonable return to the investors in territory where cheap water transportation can not be made available.

In the Mississippi Valley there is an abundance of slow, heavy freight which it is not profitable for the railroads to haul, and which is demanding an opportunity to use the waterways. The government barge line has demonstrated that there are large quantities of sugar, coffee, and other heavy commodities, as well as goods from foreign shores, seeking water transportation to the North from New Orleans, and vast quantities of coal seeking to be carried from the coal fields of Illinois and Kentucky to the St. Paul and Minneapolis district to be used for heating and manufacturing purposes. There are large quantities of iron ore in the Minneapolis district seeking cheap water transportation southward. There are steel and iron products, tiling and brick in great quantities, and other heavy commodities seeking transportation to the south. Kansas city, St. Joseph and Omaha are in the greatest wheat-producing area in the country. Hundreds of millions of tons of this heavy freight each year are seeking to go, either in the form of grain down the Missouri and Mississippi to the sea, or in the form of flour down the Missouri and Mississippi to Cairo and up to the Ohio to the great industrial district around Pittsburgh.

The Way Ahead

If our waterways are improved, all this heavy, sluggish freight can be carried profitably by barge lines at a rate of not more than one-third, and probably one-fourth of the best rate which the rail lines can afford to make. As it is today, we are suffering a shortage in transportation, because hundreds of thousands of freight cars are engaged in the long haul of heavy, unprofitable freight from the interior to the seaboard; and the railroads are suffering not only because of

this unprofitable business, but because thousands of their freight cars, engaged in this service, are lost upon foreign lines. If this low-grade, heavy freight could be loaded upon barge lines and the cars now engaged in that service released for carrying expensive, high-grade freight on shorter hauls, not only would the rail lines be benefited and our transportation difficulties greatly relieved, but our shippers would be immeasurably benefited by the cheap rates which would inevitably result to them.

Give us a great transportation system made up of railways, waterways and highways, not contending but co-operating. Let each factor of this great system supply a service at the lowest rate of which it is capable, and let the shippers pay to each of them a rate which is compensatory for the service rendered and which will yield to the investor a reasonable return upon his capital. Yes, more than that, let us have a great system of transportation, with highways developed so that the motor truck can go to the farmer and into his fields and assemble his commodities along the rail lines. Let us have railways, a larger unit of transportation to assemble these commodities, especially the slow, heavy commodities, along our inland rivers, where the barge line—a still larger and cheaper unit of transportation—can carry them to distributing centers or to the seaboard of the nation.

Before a system of transportation such as I have described can be realized in this country, two things must be accomplished:

First, the projects for the improvement of our inland rivers which have been established by act of Congress, should be completed, in order that these rivers may be made ready and available for navigation.

Second, the rail abuses should be abolished by law, and the rail and water lines should be converted from conflicting, contending forces to a co-ordinated, co-operative system endeavoring to serve the commerce of the country. When such legislation is enacted, which will guarantee freedom from ruinous and confiscatory competition, abundant capital will be available for investment in river equipment sufficient to supply every demand of commerce for river transportation.

THE TRUCK AS THE RAILROAD'S ALLY

By Roy D. Chapin, Chairman of the Board, Hudson Motor Car Co., Detroit, Mich.

The actual competition between rail and motor carriers today is negligible; and where it does exist, it is largely due to the fact that the rail lines, suffering from undue regulation and cramped beyond reason financially, have been unable to provide desired facilities.

Relief for the railroads from the unprofitable short haul, or rate increases which will make this service pay for itself, seem to offer solutions to their difficulties. Perhaps use of gasoline equipment such as that now employed by forty railroads will serve in many cases.

As for the long haul, the plain fact is that the motor vehicle operator does not want and does not believe in it, save under exceptional conditions, and usually these have been forced upon him.

Last year the motor industry, for example, was compelled to drive away from the factories more than three hundred thousand motor vehicles for delivery to buyers. Does anyone believe that this was done from choice? Is it not apparent at once that only lack of rail facilities forced an uneconomic movement of this character? Incidentally, does this not show clearly the necessity for a prosperous, efficient rail system?

In the case of passenger travel, perhaps the steam lines would do well to consider long bus operations, especially in scenic country, as a supplement to their rail facilities.

The field of operation in the terminal area appears to be one solution to the question which has not yet been given full consideration.

Responsible railroad executives have said that 25 per cent of railroad equipment is absorbed in the haulage of less than 5 per cent of the commodity movement and that it returns but about 10 per cent of the revenue.

This is the less-than-carload movement, in which is involved most of the terminal troubles to which the railroad men of the present generation have fallen heir.

Terminal facilities, taken to mean all other than main line facilities, another authority has said, represent about 50 per cent of the total capital investment of the rail lines.

Much present railroad practice is a heritage of the horse-drawn days of high-

way traffic. Then the railroads had to place their stations close together, close to industrial areas, and had to use freight cars over short spurs to facilitate freight movements.

As our cities have grown, the valuations on these terminal properties have swollen to unbelievable proportions, carrying with them enormous increases in fixed and operating expenses. The facilities are no longer adequate, yet to add to them would cost stupendous sums.

Once added, the result would be a congestion of our city streets even worse than that of the present, and at best relief would be but temporary.

Now consider the alternative. The railroads instead of coming into the center of the city for freight terminals could afford to move them well out, selling their down town property. Not only would terminal charges be lessened, but the charge to the average merchant would be lower, since a trucking movement is necessary anyway and since his truck could clear more quickly if it did not have to go through crowded city streets or wait for hours at overloaded platforms.

Automatically, such an operation would release thousands of freight cars now used for deliveries, to spur lines, and the merchant would see his long-distance cargoes coming through more quickly, with a resultant decrease in the interest charges on his investment.

City development would be permitted to proceed in a more orderly fashion, the danger of closed factories due to delayed shipments of necessities would be avoided, and the wheels of commerce would move more smoothly all along the line.

Passenger traffic does not afford as critical a problem, since, as someone has put it, "the goods deliver themselves."

A store-door delivery service furnished by an organization entirely apart from the railroads which would contract to take the goods from the producer's platform and place them at the gate of the consumer, using the rail or water for the long haul and the truck for the short delivery, seems to be one answer to which we are tending.

If we can progress to this point, then the shipper will have completed transportation involving the shortest length of time for each operation. He will find his inventories cut down, as he will no longer have to carry huge stocks on hand; the interest on goods in transit will be decreased; fresh goods can be constantly maintained ;and the greater turnover, of course, means a greater profit.

Similarly, the railroad will have its capital charges, as well as operation costs, reduced, and its equipment left free for use in the profitable long haul.

One of the best forms of transportation which we shall see in our day will be the perfection of the unit container system which is now being tested by the New York Central and perhaps other rail lines. This involves the use of a unit body which can be transferred from truck to train, to boat, to electric line, to truck, without repacking and by a simple crane operation.

The questions of a closer co-ordination of motor bus and electric line in the serving of urban and interurban passenger traffic have afforded investors in traction stocks some anxious moments in the past, but the relations in these fields are now generally understood to be complementary rather than competitive, and with that point in mind traction operators are now going into the bus field.

The electric line, either surface or subway, is the present great purveyor of mass transportation in the cities. Differences of opinion have developed among experts as to the future trend of this traffic. What is the field of the bus line on the main thoroughfares of cities? Have London and Paris something to teach us in this respect?

It is quite natural that the advent of a new form of transportation should bring with it new problems and obstacles which must be overcome before the public and other transport agencies can reap the full benefit of its use.

When the railroads were first developed, history shows that they were not properly appreciated, and it was only as the public came to a realization of their possibilities as carriers that they were accorded full recognition.

The rise of modern highway transport is without parallel in the rapidity with which it has won popular favor, but there still remains much to be done before we can achieve that completed transportation which the public demands.

As one case in point, while we now have some 350,000 miles of improved highway, 259,000 miles of railway, 18,000 miles of interurban electric line and 15,000 miles of inland canals and waterways, none of the older forms of transport can reap the full benefit from highway transport until a much larger percentage of our

2,800,000-odd miles of highway are made ready for constant traffic.

Government surveys in Connecticut, Tennessee, Maryland and elsewhere show conclusively that by far the largest percentage of traffic, even over our main highways, is purely local. Highways, paralleled by other carriers in many instances but still largely destined for "feeder" uses, must be improved in every state, in order that the rail, water and electric lines shall realize their full volume of travel, and, more important, that the public shall derive the benefit of lowered transport charges, which logically and naturally follow improved highways.

At the same time, politics must be eliminated from our highway program an dcentralized economic and engineering control should determine the order, character, and extent of road improvement upon a basis of future traffic requirements. There should be a definite correlation between interstate, state, county and local systems; and the annual highway budget should be adjusted to relative tax needs for other public purposes.

A charge which the public is now subject to is excessive special taxation levied against transportation agencies, which the public as consumers of the commodities must pay.

Thus, for example, a study made from government figures by John E. Walker, formerly tax advisor to the Treasury, shows that the rail lines contributed approximately $304,000,000 in taxes in 1922.

Motor users paid special taxes of $340,000,000 in 1922, or the equivalent of nearly one-half of the total highway construction and maintenance bill of the nation, estimated at $742,000,000. Of that amount, $120,000,000 were discriminatory taxes levied by the Federal Government and exactly comparable to those railroad taxes which, also growing out of the war, were repealed by a recent session of Congress.

We take no issue with that portion of the remainder expended in the upkeep of highways, as we believe that the user should pay a fair charge for service rendered. But those taxes which are levied for construction or which do not go into highway work at all, constitute the payment of general benefits through special levies which add materially to the cost of the public of this form of transportation.

Other large taxes are assessed against the electric lines and other carriers, yet inevitably the consumer must pay. In all these cases, then, we have an artificial barrier imposed in the way of efficient transportation at the lowest cost to the using public.

Inevitably, too, these barriers must be recognized as standing in the way of the most effective use of the motor by the rail and electric lines.

It seems further that the motor truck and the passenger car must take the place of thousands of miles of short-line railroads which were originally built and operated only because the cheaper and more flexible medium was not in existence.

Again, it is apparent that rules and regulations designed to cover old forms of transport can not always be made to apply to a new form.

For example, there is the question of proper regulation of the motor. Of course the vehicle should be required to comply with every regulation having to do with the safety of life, limb and property. That is fundamental. Overloading should not be tolerated nor reckless driving. There should be reasonable restrictions to protect the highway, but there should also be a recognition that the highway is of service only as it is used; and, accordingly, there should be a proper balance between road and vehicle as well as between vehicle and road.

Proper correlation of traffic is likely also to imply exclusive franchises in return for the regular service which the public has a right to demand.

I have already tried to indicate the far-flung influence of highway transport on our ways of life. We can not hope to see that influence fully realized unless we make systematic efforts to increase our facilities in our cities as well as in our rural communities.

The evils of congestion in densely populated areas tend to slow down every form of transport, and in doing so they stem the flow of people and business, to the injury of all transportation and of the public.

There must be extended research, and our universities and other educational institutions must train thousands of men for us, if we are to obtain adequate answers to this highly complex problem of completed transportation.

The responsibility for finding the answer to this question rests with the motor industry, the railroads, the other carriers and the lawmakers.

But over and above all remains the ever-paramount need of conserving the

welfare of the public, and of the nation, if you please. We can only attain the desired goal if we keep that need always in mind.

The foregoing address by Mr. Chapin was delivered before the recent annual convention of the Chamber of Commerce of the United States.

PAINTING CONCRETE SWIMMING POOLS

The question of keeping concrete swimming pools in good condition during the coming season is now uppermost in the minds of many athletic managers and municipal directors. The following statement prepared by an expert and appearing in the "Oval," the house organ of the Du Pont paint and varnish lines, gives some interesting data on this subject. Under the heading "Painting Concrete Swimming Pools," the author says:

The success of a job of this kind depends more on the correct application of the paint than on the paint itself. One of the essentials is plenty of time to permit the different coats to dry properly and the final coat to dry hard.

First, the surface should be thoroughly cleaned. Grease should be removed by washing with gasoline, and dirt by washing with soap and water. The surface must be thoroughly dry before the first coat is applied, in order to permit the proper penetration of the paint.

The first coat should be white enamel undercoat, thinned with elastic wall primer if the surface is of a porous nature, and with turpentine if the surface is hard and non-porous. It is essential to get good adhesion in the first coat.

The second coat of white enamel undercoat should be applied as found in the container.

If the surface is rough, a third and fourth coat of white enamel undercoat is advisable. The coating, when completed, must be continuous so that there are no breaks in the film whatever, which would permit water to get back into the concrete and later force the paint away.

The job to be finished should be given two coats of bath tub and refrigerator enamel.

If the different coats are given sufficient time to dry, the procedure as outlined will produce as satisfactory a coating as anything that can be offered for painting concrete surfaces which come in contact with water.

The three prime essentials are:

1. Dry surface.

2. Plenty of time for the different coats to dry.

3. The finished job must be an impermeable unbroken coat, so as not to permit water to get back into the concrete.

EVINRUDE PUMP SAVES FIRE-THREATENED TOWN

Reports recently appeared in the Duluth daily papers telling how the little town of Central Lakes, Minn., was saved from fire by the use of an Evinrude Centrifugal pump. Forest fires had been threatening this village of 150 inhabitants for some time but by consistent back-firing it had been saved. Upon this occasion a sawmill outfit had just been burned out and the fire was moving toward the main section of the village. The pump was brought through three miles of flaming roadway by two National Guardsmen. It was lowered into a cistern under the parlor floor of one of the Central Lakes homes and the stream of water which it threw on the fire, together with the efforts of a bucket brigade, succeeded in halting the progress of the flames.

VALUABLE TRADE LITERATURE

Crushing and Screening Plants: Austin Portable Gyratory Crushing and Screening Plants is the title of Bulletin No. 30, recently issued by the Austin Manufacturing Co., 400 N. Michigan Ave., Chicago. The bulletin is well illustrated and contains 16, 6x9 in pages. The newest equipment featured in the bulletin are the conveyor and the No. 4 crusher. This company now offers a complete portable crushing plant that fills the requirements of the most discriminating engineers, contractors and public officials. Some of these crushers are mounted on trucks making them easily moved from place to place by the traction engine used to drive the crushing plant. The portable gravel feeding conveyor is a great labor saver on gravel pit operation. It is made in lengths from 30 to 50 ft. and has a belt 18 ins. wide. The conveyor hopper is fed through a trap from wagons, wheelers, drags or fresnos and provides a uniform continuous feed to the crusher thereby greatly increasing its capacity.

Construction News and Equipment

THE SOMERVELL GASOLINE HAMMER DRILL

A Gasoline Impact Drill of the air hammer type is now manufactured by the Pennsylvania Gasoline Drill Company, Land Title Bldg., Philadelphia, Pa.

This drilling unit is an innovation in the drilling equipments now in practical use, it being a self-contained, portable, gasoline hammer, so powerful and compact that one man operates and transports it from place to place. Like the self-contained gasoline engine, this gasoline hammer makes its own power, therefore no other power equipment has to be transported with it.

When first seen in operation, the lack of connection to other agency of power causes wonder and forcefully brings a realization of the great power of gasoline when applied directly to the hammer piston of this drill.

The drill was first developed for drilling rock, but, because of its portability and simplicity, the advantages of its application to other work are recognized in many other lines of business such as:

Cutting asphalt streets, breaking concrete, picking hard earth, ramming back fill in trenches, removing granite block, removing wood block, drilling foundations, drilling through walls, driving tie spikes, ramming tie ballast, paving repairs, stripping, shaft sinking, and exploring.

Prior to this invention, all types of power drills were limited in their application to work by the length of an air hose or by electric wires. Power for either of these methods must be supplied to them by an auxiliary power equipment which, on account of the size and weight, cannot be cheaply transported, nor can it be located near enough to do probably more than 60 per cent of the work to which a power drill could profitably be applied.

The table gives comparative data of the weight, purchase price and practical operating costs of the gasoline drill and mounted air drilling equipment, an equal amount of work being assumed.

	Portable Air Drills	Somervell Gas Drills	Saving
Average weight	3,000 lbs.	70 lbs.	2,930 lbs.
Average selling price	$1,800	$600	$1,200
Daily gasoline consumption @ 27c gal.	16	1½	$3.91 a day
Labor @ $4.50 a day	2 men	1 man	$4.50 a day

Transportation and upkeep costs, not estimated.

Opening Philadelphia Streets

The Philadelphia Electric Company, by the direction of Mr. J. Wilson Sylvester, Superintendent of A. C. and Arc Underground Lines of that Company, has made

COMPLETE DRILLING UNIT OPERTING

tests of the gasoline hammer extending over several weeks' time. The work included the operations required for the opening of city streets.

Particular attention was paid to the performance of the gasoline hammer in such work as cutting asphalt, breaking concrete bases, picking frozen earth and tamping back fill. Records of the saving in labor costs of the various operations were carefully kept.

The following is the average time in which the gasoline hammer will do the

work as compared with the time required by hand labor, paid $4.50 a day:

	Hand Labor	Gasoline Hammer	Daily Saving in Labor
Cutting asphalt surface	2½ men	1 man	$ 6.75
Breaking concrete base	5 men	1 man	18.00
Picking frozen earth	2½ men	1 man	6.75
Ramming back fill	8 men	3 men	22.50

For ramming back fill a cast steel tamper 8½x8½ ins. is used. The back fill is so solidly compacted by the gasoline hammer that after the installation of a service conduit 4½ ins. square for the length of the ditch, it was found possible to replace all of the earth removed, thus insuring a more substantial foundation than existed before being disturbed. This precludes the possibility of future settlement as well as eliminating the cost of removal of surplus dirt.

It appears to be practically impossible to re-compact the earth by hand labor to prevent it from later settling and causing a depression, but the gasoline hammer will re-compact the earth as tight and as hard as when first removed.

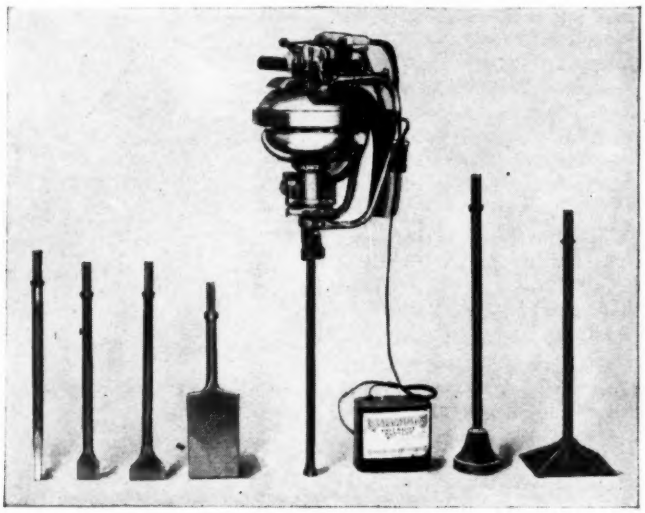
Telegraph Pole Lines

Because of the lack of sufficiently portable power drills, the Western Union Telegraph Co. has experienced difficulty and great expense when excavating for pole lines in rocky and inaccessible places. Upon their engineers witnessing the performance of this gasoline hammer drill and seeing that it can easily be taken wherever man can go, its advantages for this and many other kinds of work were recognized and an order for a number of them was given.

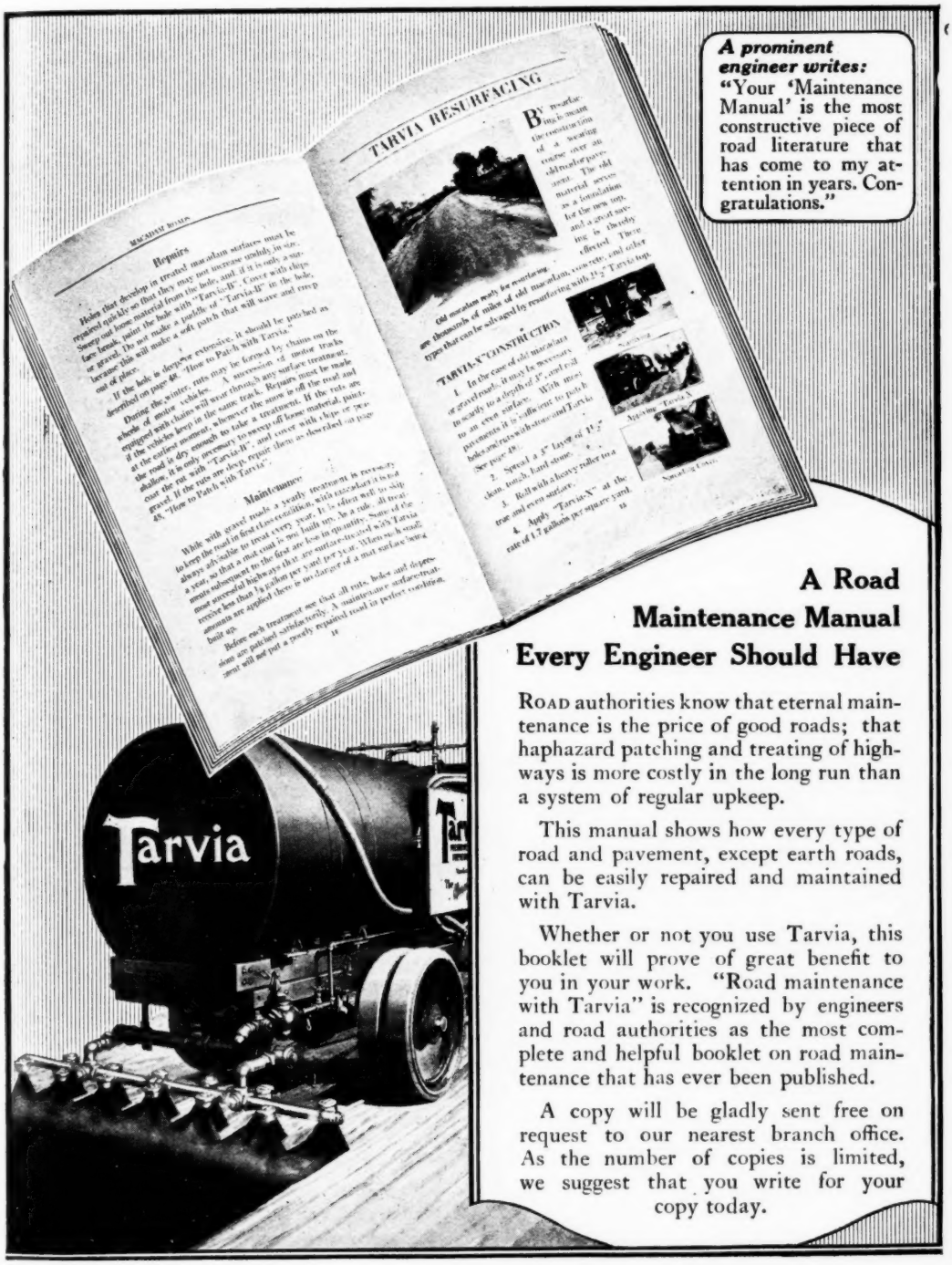
Gasoline Drill Construction

The mechanical principle of this gasoline hammer drill combines the action of an air hammer and a gasoline engine in such manner that the drilling unit has but two moving parts, the hammer piston and the fly wheel assembly. No crank shaft or connecting rod is employed and there is no spring or other yielding member used in the internal construction. No inlet or exhaust valves or cam shafts are used, as the air and gas passages are fixed ports, cut through the solid steel of the cylinder.

The down or power strokes of the hammer pistons are made with approximately 900 lbs. of gasoline explosive force thrusting it forward to hit the drill bit with terrific force. The fly wheel is employed only to return the hammer piston on the upward or compression strokes. Approximately 1,800 impacts are struck each minute. For carburation, a gasoline mixing valve is used which permits the drill to be worked at any angle. While the drill continues to run at full speed, the operator shifts it from one position to another and to any desired angle without affecting its operation. To start the drill, the operator has but to give the rim of the fly wheel a pull by hand and even in the coldest weather it starts "with consistent regularity" as was remarked by Mr. W. K.



DRILL WITH STREET OPENING TOOL



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ROAD authorities know that eternal maintenance is the price of good roads; that haphazard patching and treating of highways is more costly in the long run than a system of regular upkeep.

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Lubrication of all parts of the drill is assured by the means of scoops, fixed to the hub of the fly wheel, which in turn, runs in a reservoir of oil and delivers a copious supply to all moving parts. A pint of oil will lubricate the drill for a week. A four or six dry cell battery is used for ignition.

Under the guidance of metallurgists

RAMMING BACK FILL

having long experience with steels of high fatigue values, special alloys having 210,000 lbs of tensile strength are used in the impact members of the structure. To avoid checks, flaws and other imperfections such parts are machined from solid steel billets. When heat treating these parts, recording instruments are employed to avoid unknown variations in the heats thus assuring uniformity in the steels.

The manufacturing of the drill is done under close inspection. Machining dimensions with very close tolerances are fixed to assure the interchange of repair parts. Highly skilled mechanics are employed working under experienced management.

Three years of uninterrupted application to the development have been spent in bringing this gasoline hammer drill to this stage of perfection, and it has been refined to such an extent that a monkey wrench and a screw driver only are needed to take the whole drill apart and to put it together again, no mechanical skill of any degree being necessary.

CARRYING SERVICE TO THE "CATERPILLAR" OWNER AND OPERATOR

The Holt Manufacturing Co., recognizing the need for greater tractor knowledge on the part of owners and operators of "Caterpillar" tractors, is meeting the problem in the most direct and thorough manner. A complete educational program is in operation, one of the important features being service schools, conducted at various points throughout the country.

In these schools special attention has been given to the mechanical equipment of each model "caterpillar." Complete tractors, cut away assemblies, including engines, clutches, transmissions, roller frame assemblies, etc., are used. These assemblies are so prepared that not only can the student closely follow and materially profit by the instructors' explanatory lectures, but in the shop work which follows every lecture, the student, by virtue of the special cut away features, can more readily carry on with the work assigned him of disassembling and reassembling.

The school work is sufficiently long to cover every feature of the construction, operation and maintenance of "caterpillar" tractors.

These schools are carried on under the personal supervision of H. H. (Jack) Chambers, Service Manager of the Holt Manufacturing Co., aided by H. S. Hinrichs, Assistant, and Messrs. Earl J. Howey and Jack Westphal, Service Instructors, all men of broad experience in all phases of tractor work. These schools are meeting with the hearty approval of customers.

In addition to service schools, the educational program includes instruction books furnished every user and a continuous follow-up of service bulletins and letters of advice relating to "caterpillar" tractors. The results the Holt Manufacturing Co. is obtaining conclusively prove that he who serves to the utmost profits most in the end.

Contracts Awarded

ROADS AND STREETS

Ala., Geneva—Southern Roads Co., Birmingham, awarded contract for about 1 mile street paving on Commerce and Town Sts. Bitulithic and conc. base. Streets 100 ft. wide. J. R. Carter, Geneva, has contr. for abt. 5 miles sidewalks, gutters and curbs. Cost of impvts. willl aggregate $175,000 raised by assessment bonds.

Ariz., National Forest Road—L. C. Lashmet, Albuquerque, N. M., awarded contract by U. S. Bureau Pub. Rds., at (a) $71,979 (using Alt. No. 1) for constr. of Flagstaff-Angell Forest Rd., 23.436 miles, 24 ft. wide, Cocohino National Forest, Arizona.

Cal., Colton—Hall-Johnson Co., P. O. Box 51, Lynwood, award. contract for paving certain streets in Colton, at $111,563, involving 505,724 sq. ft. 4-in. Willite paving.

Cal., Long Beach—California Constr. Co., 58 Second St., San Francisco, awarded contract for conc. paving, also constructing storm and san. sewer systems, etc., in Belmont Shore Dist., at $556,112.

Cal., Los Angeles—Geo. R. Curtis, 2440 E. 26th St., awarded contract by County Supvrs., for paving Alameda St. in Road Dist. No. 4 bet. S. city limits of Compton an no. city limits of Wilmington, 5.77 miles 8-in. concrete pavement at $148,962.

Cal., Los Angeles—Tryon & Brain, 201 Tajo Bldg., awarded contract for impvt. of Western Ave.—Slauson to Manchester Aves.—at $259,185; F. W. McRae, Santa Monica Canyon Apts., Santa Monica, awarded contract for improving 1st alley eact of San Fernando Rd. bet. Maceo and Poplar Sts., and portion of other streets, at $4,096.

Conn., Hartford—W. H. Arthur, Washington Bldg., Stamford, award. contract by St. Hwy. Comn., for paving 25,000 sq. yds. conc. in Greenwich, at $108,000; 6,000 ft. in Glastonbury, 18 ft. waterbound macadam to D. Arrigoni & Bro., Middletown, at $28,000; 4,000 ft. in Westport, 18 ft. bitum. conc., to Stillman & Godfrey Co., 133 Admiral St., Bridgeport, at $43,000.

Fla., Sebring—Walter J. Bryson Paving Co. and McCormick & Delaney, La Belle, Fla., awarded contract for construction of main highway thru Highlands Co. Polk to Glades Co., at $406,350.

Idaho, Boise—J. C. McGuire, Pocatello, awarded contract by State Bureau of Hwys., for 6.78 miles paving on Yellowstone Park Hwys., Bingham Co., at $211,787.

Ill., Springfield—Following contracts let by State Highway Dept., F. A. P. 56, Sec. 18 and 13, Ford Co., 7.04 mi. and 5.87 miles to I. D. Lain, Bloomington, Ill. and Chas. W. Clark Co., 511 Terre Haute Tr. Bldg., Terre Haute, Ind., at $144,045 and $96,982, respectively; F. A. P, 58, S. 18, Christian-Montgomery Co., 5.12 miles to Jos. Kesl & Sons, Edwardsville, Ill., at $110,888; F. A. P. 59, Kane-Nendall Cos., 8.12 mi. to J. J. Dunnegan Constr. Co., Shenandoah, Ia., at $161,826; F. A. P. 60, McHenry-Lake Co., 4.27 miles to same contractor at $95,103; F. A. P. 24, S 2, Lake Co. 5.34 miles to Northern States Constr. Co., Waterlloo, Ia., at $107,968; F. A. P. 59, S. 15, Will Co., 5.58 miles to Chicago Heights Coal Co., Chicago Hts., Ill., at $22,000, also contr. for S. 16, Will-Kane Kendall Cos., 5.19 miles (this being included in contr. price stated above); F. A. P. 61, Secs. 28, 29, 30 in Champaign Co., 6.06, 4.96 and 4.88 mi., S. 31, Champaign Ford Co., S. 32, Ford Co., 4.86, and 2.74 miles, to P. Verhey, Champaign, at $419,740; S. 1, Carrolll Co., F. A. P. 39, 2.73 mi. to C. C. Vanderboom & Sons, Mt. Carroll, Ill., at $61,470; F. A. P. 63, Secs. 4 and 5, Knox-Henry and Knox Co., 4.40 and 4.94 miles to I. W. Bowman Co., 1117 Third Ave. Peoria, Ill., at $171,973; F. A. P. 65, S. 21, Fulton Co., 5.45 miles to Russell Condon Constr. Co., Omaha, Neb. at $115,939; F. A. P. 66, S. 3, Moultrie Co., 7.95 miles to J. W. Etchison, Casey, Ill., at $148,942; F. A. P. 67, S. 113, Lake Co., 3.91 miles to J. J. Dunnegan Constr. Co., Shenandoah, Ia., at $85,397.

Ill., Springfield—Following contracts let by State Highway Dept.: S. B. I. Rte. F. A. P., 70, Sec. 5, Richland Co., 6.60 miles to Wabash Constr. Co., Vincennes, Ind., at $139,068; S: B: I. 14 F. A. P. 71, Sec. 4, Franklin Co., 5.56 mi. to Keeley Bros. Contr. Co., E. St. Louis, Ill., at $129,717; S. B. I. 25, F. A. P. 23, S 7, Clay Co., 3.54 mi. to Edwardsville Constr. Co., Edwardsville, Ill., at $71,662,000; S. B. I. 25, F. A. P. 73, Douglas Co., 7.32 mi. to W. F. Smith & Co., 505 Ill. Natl. Bk. Bldg., Springfield, at

Prompt Shipments

BEST EXTENSIBLE TRENCHING BRACE MADE

KALAMAZOO F'DRY & MACHINE CO. MICHIGAN

594 EAST MAIN ST.

STEWART SEWER CLEANING MACHINE

Water Cleaning System, if you wish it, or Drag Bucket type.

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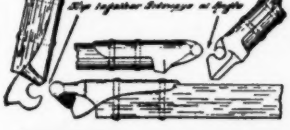

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PROMPT DELIVERIES. LET US QUOTE YOU PRICES.

$122,259; S. B. I. 26, F. A. P. 74, S. 2, Ogle Co., 5.62 miles to Webber Co., Ionia, Mich., at $126,094; S. B. I. 43, F. A. P. 72, S. 1, Mason Co., 5.3 miles to W. F. Smith & Co., Springfield, at $104,181; Type for all pavement sections is for Portland cem. concrete.. S. B. I. Route 3, F. A. P. 47, S. 66, Monroe Co., 1.18 mi. to Dawson-Bowers Constr. Co., St. Louis, Mo, at $17,495; S. B. I. Rte. 7, F. A. P. 27, Secs. 38A & 38, Woodford Co., 0.11 and 0.14 mi. to I. D. Lain, Bloomington, Ill., at $2,641 and $2,561, respect.; S. B. I. 21, F. A. P. 24, S. 2A, Lake Co., 1.08 mi. to Jas. Cape & Sons, Co., Racine, Wis., at $17,742; F. A. P. 7, S. 2,LaSalle Co., 0.37 mi. to G. W. Comstock, Peoria, Ill., at $7,203. Type for all sects. Portland cem. conc., and width to be constructed by State is 18 ft. F. A. P. 2, S. 11, Will Co., 0.20 mi. to J. M. Pierson & Co., Chicago Heights, Ill., at $5,740; F. A. P. 52, S. 4, White Co., 4.07 mi. to C. J. Moritz, Inc., Effingham, Ill., at $73,442; Secs. 20 & 21 Crawford Co., 4.54 mi. and 2.86 mi. to J. W. Etchison, Casey, Ill., at $154,444 (all on S. B. I. Rte. 1); Sec. 12, Union Co., 4.81 mi. to Jos. Kesl & Sons, Edwardsville, Ill., at $103,476 and F. A. P. 54, S. 51, Macon Co., 5.50 mi. to McMahon Constr. Co., Rochester, Ind., at $87,575; (S. B. I. Rte. 2).

Ill., St. Anne—H. C. Finley Constr. Co., Hoopeston, awarded contract for 33,000 sq. yds. rein. conc. paving, at $106,098.

Ind., Albion—W. L. Johnson Constr. Co., 1205 N. Bellview Pl., Indianapolis, awarded contract for conc. paving (75,696 sq. yds. Stacy St. Rd.) at $136,645.

Kan., Iola—Harrison Engrg. & Constr. Corp., New York, 418 Sedgwick Bldg., Wichita, awarded contract for grading, bridging and paving 5.187 miles F. A. P. 125, Sec. B, at $160,244.

Ky., Frankfort—Following contracts let by State Hwy. Comn.: June 11, Christian County to McQuary Bros., Hopkinsville, Ky., for gravel, at $192,684; Hopkins Co. to N. E. Stone & Co., Madisonville, for gravel at $255,094; Kenton & Boone Cos., to Jno. Wroe, Dayton, O., for rein. conc., at $316,788; Mason Co. to Bates, Paynter Co., Danville, Ky., for waterbound macadam, at $47,511; Pike Co. to N. K. Snead & Co., Huntington, W. Va., grade and drain., at $123,092; Union Co., to W. W. Carter, Clay, Ky., grade and drain., at $123,454.

Me., Augusta—State Hwy. Comn. let contract to I. J. Murphy, Somerville, Mass., for paving 4.3 miles, Somerset Co.; 2,450 sq. yds. bitum. macadam, $2.50, 14,000 c. y. excav., $1.35, etc.—total, $113,625; 4.535 mi. Cumberland Co., 2,231 sq. yds. bitum. macadam, $2.50, 14,989 c. y. excav., $1.50, etc. $102,430; H. H. Day, Bangor, 2.32 miles, Penobscot Co., $32,433.

Mass., Boston—Power Bros., 167 N. Montello St., Brockton, awarded contract for 3.25 miles road in Plymouth, Conc. and waterbound macadam, at $259,750.

Mich., Detroit—Detroit Asphalt Paving Co., 20 McGraw Bldg., paving Carpenter Ave., $57,781, Fenkell Sec. 1, $48,484, Kenkell Ave., Sec. 2, $45,447, Harper Ave., Sec. 1, at $109,676, Harper Ave., Sec. 2, $94,052; Hussar Ave., $6,772, Mack Ave., $25,348, Hardin Ave., $17,136, Quincy Ave., $13,349; Cleveland Trinidad Paving Co., 402 Hammond Bldg.,. Linewood Ave., $48,005, Leslie Ave., $47,700; Normandy Ave., $47,505—all 3½-in. sheet asph. (nat. lake or oil) on 8-in. concrete.

Mich., Saginaw—W. E. Foale Co., Saginaw, has contract for constr. of 10.54 miles assessment district road No. 57—St. Charles to Oakley, Saginaw, at $205,604.

Minn., St. Paul—McCree, Moos Co., 711 Merchants Bank Bldg., St. Paul, awarded contract for paving in Ramsey Co., Phalen-White Bear Rd.—Larpenteur Ave. to Goose Lake and Co. Rd. east Koehler Rd. from Centerville rd. to Washington Co. line, 1 course 7½ in. r. c., trap rock or granite, at $288,479.

Mo., Clinton—Joseph Pope, Jefferson City, awarded contract for 6 miles conc. road near Windsor, Henry County, at $200,000.

Mo., St. Charles—Bangert Bros. Constr. Co., Ferguson, Mo., awarded contract by St. Charles Co. Court to improve 4 miles Boone's Lick road—Harvester to Cottleville; 3 miles Tarvia and 1 mile gravel, at $119,376.

Mont., Helena—Following contracts let for road and bridges: B. P. Melchert & Co., Lewistown, 39 miles hwy. on Fed. Aid projects in Glacier and Pondera Cos., at $280,595—Dupuyer-Glacier and Browning-Carlow Rd.; bridges to W. P. Roscoe, Billings, at $56,030.

Neb., Omaha—National Constr. Co., 1315 S. 20th Omaha, award. contract for brick paving on following: Proj. 100, $157,455; Proj. 20B, $161,599.

Nev., Carson City—Ken. Hodgman, Klamath Falls, Ore., awarded contr. by Hwy. Dept., for constr. of state hwy., Humboldt Co., bet. Winnemucca and Toll House, Rte. 8, Sec. A, 11.87 miles, at $88,918; Jno. Ross, Yerington, Nev., awarded contract for constr. of state hwy. in Humboldt Co. —Toll House to Paradise Hill, Rte. 8, Sec. B; 12.25 miles, at $71,054.

N. J., Audubon—Union Paving Co., 30th & Locust Sts., Phila., awarded contract for conc. paving on various streets, at $321,718.

N. Y., Poughkeepsie—Spoor-Lasher Co., Inc., Market St., awarded contr. by Bd. Pub. Wks., Eastman Park Mansion, for asph. granite blk. and brick pavements, etc., at $316,691.

N. Y., Troy—Fitzgerald Bros. Constr. Co., Proctor Bldg., awarded contract for concrete paving on Lanin Court, 6th Ave. 2nd, 18th and 23d Sts., at $170,503.

N. C., Spencer—R. G. Lassiter Constr. Co., Citizens Bank Bldg., Raleigh, awarded contract for hard surfacing various streets, at $200,000.

N. J., Newark—Contract for curbing and flagging Carolina Ave., awarded to Flipponen, Scanniello & Caposio, 246 Littleton Ave., at $5,692; asph. paving 29,250 sq. yds. Maple Pl., Leslie and Boylan Sts., Vassar, Vermont, Lindsley, 13th and Irving Aves. to Standard Bitulithic Co., 50 Church St., New York City, at $146,836; J. P. Dosch, 501 Bloomfield Ave., Montclair, awarded contract for supplying and applying asph. road oil on designated roads, quantity to be used not less than 10,000 gals., nor more than 60,000 gals., at $0.0725 per gal.

N. J., Newark—J. B. Gilligan-Casey Co., 919 Broad St., awarded contract for grading and paving 31,500 sq. yds. Chancellor Ave., asph. on conc., at $100,945.

N. Y., Buffalo—Rock Asphalt Paving Co., Morgan Bldg., asphalt paving on Olive St., $18,385, S. Elmwood Ave., $24,961, Niagara St., $130,130; H. P. Burgard Co., 1968 Fillmore Ave., asph. paving Lathrop St., $18,030, Sanford St., $8,700, Hazel Pl., $15,000, Amsterdam Ave., $11,285, Fleming St., $29,345.

O., Cincinnati—Henkel & Sullivan, 105 Bell Blk., awarded contract for 6,681 ft. paving on Liston Ave., at $179,086.

O., Euclid—Cleveland Trinidad Paving Co., The Arcade, Cleveland, awarded contract for grading, cement curbing and asph. paving on various thoroughfares, at $159,796.

O., Cleveland—Cleveland Trinidad Paving Co., The Arcade, award. contract for curbing and repaving 21,620 sq. yds. Prospect Ave. with asph., at $82,462.

O., Columbus—Dept. Hwys. & Pub.. Wks. awarded following contracts: F. J. Mann & Sons, Ashland, grading, bridging and paving 1.679 mi. Sec. A Mansfield-Wooster Rd., at $95,709, 0.536 mi. Sec. Mifflin, Mansfield-Wooster Rd., at $33,516; 3.731 mi. Sec. B, Mansfield-Wooster Rd., $229,356; 0.344 mi. Sec. "Hayesville" Mansfield-Wooster Rd., $16,334 (all foregoing brick), Ashland Co.; Acton Bros., Vaughnsville, 2.778 mi. Sec. A, Deshler-Findlay Rd., $83,069 and 0.436 mi. Sec. E, Ottawa-Findlay Rd., $13,095, both rein. conc., Hancock Co.; Curry & Hayes, Cadiz, 3.183 mi. Sec. J, Bridgeport-Cadiz Rd. bitum. macadam, Harrison Co., $114,974; Straw & Huber, Paulding, 2.623 mi. Sec. A-2, Logan-McArthur Rd.—Hocking Co., brick, at $89,267; G. B. Smith Co., Youngstown, 2.531 mi. Sec. Z, Canfield-Poland Rd., Mahoning Co., bitum. macadam, tar, $55,613; Modern Constr. Co., Fremont, 3.833 mi. Sec. F, Fremont-Pt. Clinton Rd., $117,354 and 0.433 mi. Sec. "Port-Clinton" Fremont-Pt. Clinton Rd., $26,904, both rein. conc. Ottawa Co.; J. Frantz, Sidney, 1.9 miles Sec. G, Piqua St. Mary's Rd., ShelbyCo., rein. conc., $94,685; Putnam & Shindeldecker, Van Wert, widening with conc. curb 5.446 mi. Sec. K and L, Norwalk-Bellevue Rd., Huron Co., $49,766; E. A. Freshwater Co., Painesville, 2-in. conc. curb on 7.715 mi. Sec. J and 5.433 mi. Sec. Q, Cleveland-Buffalo Rd., Lake Co., $64,762 and $46,764, respectively; A. Bates,

Convoy, 2 brdgs. on Sec R. Van Wert-Ft. Wayne Rd., Van Wert Co., at $5,052.

Pa., Scranton—H. B. Sproul Constr. Co., Scranton, awarded contract for asphalt pavement on Wheeler Ave., at $97,822; on Harrison Ave., to Sweeney Bros., Scranton, at $73,522; on Monsey Ave., to W. Stipp & Son, 1015 N. Main Ave., at $27,021.

Tenn., Dyersburg—Lawrence Constr. Co., Jackson, Miss., awarded contract at about $100,000 for 11 miles hard surface road at Dyersburg, Dyer Co.

Tenn., Elizabethton—Municipal Paving & Construction Co., Bristol, Tenn., awarded contract for paving, installing sewers and water mains in entire business sect., including streets to E. Tenn. & Western, No. & Southern Ry. stations—asph on conc. base, at $130,000 to $150,000.

Tenn., Jacksboro—J. F. Marcum, Fountain City, Knoxville, Tenn., awarded contract to grade and lay penetration macadam on 8 miles of road from Red Ash to Pioneer, at $150,000.

Tenn., Newport—Murray Constr. Co., Holston Natl. Bank Bldg., Knoxville, awarded contract for asphalt paving on various streets, at $115,000.

Tex., Beaumont—Houston Constr. Co., Houston, awarded contract to resurface with sheet asphalt Forsythe, Park, Crockett Sts. and Railroad Ave.; Uvalde Rock Asphalt Co., San Antonio, at $306,770 to pave Liberty, Grand and Penn. Aves., Wash. Blvd., Neches and 5th Sts. and Bway., at $306,770.

Tex., Cleburne—G. A. McClung Constr. Co., Cleburne, awarded contract to gravel and construct bridges on primary road in Johnson Co., at $248,000.

Tex., Palo Pinto—Smith Bros., American Natl. Bank Bldg., Dallas, awarded contracts to construct 2 roads as follows: Grade, construct draing. structs. and lay macadam base on 5.81 miles S. H. No. 1, F. A. P. 356, at $81,945; and 9.81 miles S. H. No. 1, F. A. P. 369, at $154,400.

Tex., Rockwell—McCollum Constr. Co., 1507 E. & M. Bank Bldg., Ft. Worth, awarded contract to build 10.1 miles single track concrete road from Royse City to intersection of Rockwall-Chisholm rd.; 50,000 sq. yds. pavement; 120,000 lbs. rein. steel, at $132,272.

Va., Abingdon—Warden Construction Co., Pulaski, Va., awarded contract at about $100,000 to improve 8 roads in Glade Spring Dist., Washington County.

W. Va., So. Charleston—Reed & Lapsley, So. Charleston, awarded contract to pave E. Quincy and C Sts., 2d, 5th, 7th and 9th Aves., Montrose Drive, part of county road, at $150,000.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Alhambra—Geo. W. Kemper, Venice, P. O. Box 223, awarded contract for constr. of sewers in Dist. No. 2, at $72,499. Work involves 8-in. vit. pipe, man holes, flush tanks, Ys and 4-in. house connections.

Cal., Riverside—H. D. Churchill & Co., 350 Merrick St. Los Angeles, awarded contract for constr. of approx 11 miles sewer work. Work totals about $117,000 and will take about 6 mos.

Cal., Whittier—H. Hanawalt, La Verne, awarded contract for constructing lower end of outfall sewer and disposal works, including Imhoff tanks and sludge beds, at $48,000 (filter not included).

D. C., Washington—District Commrs. let contracts for sewer construction as follows. W. F. Brenizer Co., 305 Q St., N. W. Washington, at $53,840 for constr. of upper Potomac intercepter bet. aqueduct brdg. and Potomac Ave.; Adam McCandish at $20,939 for constr. of Falls Branch storm sewer bet. River Rd. and Davenport St. Wisc Ave. and Fessenden St. to Wm. F. Cush at $7,715 for constr. of Sumner road service sewer from Bolling field to Nichols Ave. at $1,518 for Queda St. serv. sewer from Broad Branch Rd. to 33rd St. and for Military rd. service bet. Conn. Ave. & 32nd St.

Fla., St. Petersburg—Gedney & Murphy Co. 211 Lbr. Exch. Minneapolis, Minn., awarded contract for storm water drains in W Central Ave. Dist., at $91,726; Tangerine Ave. Dist. $41,481; 9th St. and Euclid Blvd. Dist. $97,691; 12th, 13th and Ridge Aves., Bayboro Dist., $64,403; 4th St. South and 5th Sts., South Dist., $25,289; 1st and Locust Sts., 17th, 13th and 16th Aves., Dist. $112,183—total, $432,773.

Ill., Urbana—English Bros., Lincoln Bdlg., Champaign, awardede contract by Urbana-Champaign San. Dist., for intercepting sewers, sewage disp. plant and appurts., at $489,073.

Ind., Indianapolis—Hall Constr. Co. South and Illinois Sts. awarded contract by Bd. San. Commrs. City Hall, for dehydration bldg., at $109,688.

Ky., Louisville—F. C. Williams, Fairmount Hotel, Jersey City, N. J. awarded contract for constr. of Portland relief sewer, at $143,686.

Kans., Madison—C. J. McCoy, Emporia, awarded contract for san. sewerage system and sewage disposal plant for entire city, at $50,705. Work involves 28,100 ft. 8-12 in. vit. clay pipe, 2,000 c. y. rock trenching, Imhoff tank and filter.

Mass., Andover—Cenedella & Co., Milford, awarded contract for 1,250 ft. 18-in. and 6,925 lin. ft. 24-in. c. y. force main; also 4,800 lin. ft. 30-in. tile sewer, one 24-in. c. i. outlet from Shawsheen Village to Merrimac River, at $175,000.

Mich., Detroit—Following sewer contracts let by City: J. A. Mercier Co., 616 Harmond Bldg., Blaine Ave. Arm W., $31,914; Warren Ave., Arm E., Sec. 2, $67,534; Jeynes & Affeld, 1208 Ford Bldg., Warren Ave., Arm East, Sec. 1, $53,795; Anderson & Campbell, Detroit, Warren Ave., East, Sec. 3, $48,231; Liberty Constr. Co., 1026 Detroit Savings Bank Bldg., Warren Ave., Arm East, Sec. 4, $56,687; Lennane & McIlivenna, 1112 Book Bldg., Clayton Ave., Arm Central Ave., sewer, $24,565; W. Blanck & Co., 827 Ford Bldg., Lats 3910 and 3912; $29,767 and $16,755, respectively; Oakwood Constr. Co., Oakwood Ave., Lat. 3913 and 3915, $14,000 and $17,500 respect.; Hammen & Co., 4612 Woodward Ave., Lats., 3916 and 3920, $9,473 and $15,978, respect.; C. R. Lennane Co., 2631 Woodward Ave., Lat. 3917, $12,906; Detroit Drainage Co., 5099 LeMay Ave., Lat. 3919, $17,395; Rennie & Dibble, Detroit, Lats. 3918, $11,977. Lats. to be vit. crock.

Mich., Pontiac—Rizzuto Rosario, awarded contract for constr. of sanitary sewer in Ferry Addn. streets, at $57,512; Jim Dimitroff & Co., awarded contr. for laying san. sewer in Anderson St.—Whittemore to Elm and in Elm—Anderson to East Blvd. at $6,309; Nicholoff & Nenkoff, awarded contract for san sewer in W. Huron St.—Seminole Hills Addn. to West Blvd. at $3,471.

N. J., Butler—Romano & Tozzi, Montclair, awarded contract for sewers, left unfinished by abandonment of previous contract, at $51,053.

N. J., Jersey City—J. L. Sigretto, Bernardsville, N. J., awarded contract for sewage disposal works, at $1,104,401; Sec. 3, 10 miles sewers from Dover to Boonton, to C. F. Goeringer Constr. Co., 51 S. Washington St., Wilkesbarre, Pa.

N. Y., Syracuse—J. Young, Bastable Blk., awarded contract by Bd. Constr. & Supply, Sec. E of 17th Ward sewer, 24 and 30 in. conc. and rein. conc. pipe, at $119,494.

N. Y., Tonawanda—Following contracts let by Town Board: Laying 8-48 in. pipe to W. J. Irwin & Son, Greenville, Ohio, at $379,733; furnishing and delivering 8-20 in. vit. pipe and connections to A. Lyth & Sons Co., 48 W. Eagle St. Buffalo, at $44,372; 24-48 in. conc. pipe and connections to F. H. Sherrard, 25 Morse Ave., E. Orange, N. J.; pumping station to W. L. Lose, Tonawanda, at $48,900.

O., Akron—Graham Henderson, Cleveland, awarded contract for 1 mile Hawkins Ave. interceptor sewer, 30 to 80 ft. wide, at $251,312; Mc. Alonan Bros. 197 W. Buchtel Ave., awarded contract for 6,940 ft. brk. and vit. sewer in Sawyer-Collinwood et al. at $55,613; 5,665 ft. brk. and vit. sewer in Murray-Mt. Vernon Ave., et al., at $40,158; 5,840 ft. vit. sewer in Lakemont-Hite et al at $23,123, $21,263; C. Ruhlin, 518 Metropolitan Bldg., 1,124 ft. 72-in. brick sewer in Firestone Blvd., at $34,055, $41,273.

Ohio, Cleveland—Langahan Constr. Co. Marshall Bldg., awarded contract for 8,200 ft. 12-18 in vit. clay sewer in Sec. 9-B at $100,091.

Ohio, Columbus—Sheets & Canfield, Guaranty Tile & Tr. Bldg., awarded contract for constr. 3, Sewer Dist. Franklin 1, joint intercepting sewer, 20,746 ft. 24-39 in. segmental blk. or conc. pipe at $176,641; Contr. 5, Sewer Dist. Franklinn 1. E. Main branch sewer, 19,567 ft. 10-24 in. vit. pipe,

to H. S. Bosler Constr. Co., Gugle Bldg., at $59,650.

S. Dak., Faith—Fred Pfanstiehl, Mobridge Ditching Co., Mobridge, awarded contract for sewerage system at $50,000.

Wash., Seattle—Felix Acorace & Co., awarded contract for sewers in 62nd Ave., so. et al., at $109,006 (clay).

Wis., Milwaukee—Milwaukee Bridge Co., 1400 34th St., awarded contract for struct. steel for filter and drier house on Jones Island, at $114,800. Contract awarded by Sewerage Comn.

Wis., W. Allis—F. E. Kaminski, care Hotel Irvington, Wauwatosa, awarded contract for vit. pipe san. sewers in 27 streets at $69,000.

Wis., La Crosse—C. W. Noble, 206 State Bank Bldg., awarded contr. for trunk sewers in various streets, at $69,379.

WATER SUPPLY AND PURIFICATION

Ala., Talladega—Merkle Machinery Co., Kansas City, Mo., award. contract for water works system; water to be obtained from Taylor's Mill about 4 miles so.-east of City; contract price $162,000.

Cal., Pasadena—American Casting Co., and Grinnell Co., also Mark-Lally Co. awarded contracts totaling $39,704 for furnishing pipe and fittings for City Water Dept., at $39,704; The Dorr Co., award. contract for furnishing screens and clarifiers for sewage disposal plant here, at $22,973.

Iowa, Oskaloosa—Lanning Constr. Co., Oskaloosa, awarded contract for water works plant; plumbing to Wells & Stump, Oskaloosa; Mech. Equipt. to McFarland Engrg. Co., Kans. Cit., Mo. 1 sty. bas. 40x85 brk. stone and conc., r. c. mil constr. conc. slab firs. $70,000.

Md., Baltimore—Coldwell, Wilcox & Co., Newburgh, N. T., awarded contract for installation of additional sluice gates at Montebello filtration plant at $45,295.

N. Y., New York—Clementi Contg. Co., 1195 Spofford St., awarded contract for water mains in various streets at $54,000.

N. D., Bismarck—Following contracts let for water works system: Cast Iron Pipe to American Cast Iron Pipe Co., 712 Plymouth Bldg., Minneapolis; Pipe Laying; De Graff Wolff, 988 Scheffer St., St. Paul; Filtration Plant, Reservoirs: Woodrich Constr. Co., Met. Life Bldg., Minneapolis. Total, $660,000.

Ohio, Cleveland—American Constr. Co., Marion Bldg., awarded contr. for concreting pockets at Crib 3, Lake Erie; 3,900 c. y. rubble conc., at $88,698.

Ohio, Cleveland—Stange-Walsh Constr. Co., 2315 Fairmount Rd., awarded contract for coagulation basins at Baldwin filtration plant, at $1,365,425; D. Pfahl & Co., Berea Rd., awarded contract by Cuyahoga Co., for 21,300 ft. 12 in. c. i. mains in Impvt. 28 of Co. Sewer Dist., at $120,521.

Pa., Altoona—A. L. Anderson & Bros. Inc., Altoona Trust Bldg., awarded contract by Penn. R. R. Broad Street Sta., Phila., for 250 m. g. reservoir, 475 ft. long, 68 ft. high at Tipton Run, 4 miles no. of Tipton, including 37,000 c. y. excav. and 30,000 yds. conc. and rubble masonry; also 4 miles stand. gauge r. r. traqk. Engineer's est., $1,000,000.

Pa., Harrisburg—S. W. Shoemaker & Sons, Walnut Street, awarded contract for furnishing and laying pipe and bldg. 30 m. g. rein. conc. covered reservoir, at $276,763 and $484,040, respectively.

Tex, Granbury—Municipal Engineering Co., Praetorian Bldg., Dallas, awarded contract for 2 crude oil engines, 2 centrif. motor driven pumps, c. i. pipe, steel tank, etc., at $75,000.

Tex., Greenville—Janes Contracting Co., Southwestern Life Bldg., Dallas, awarded contract for 4,750 ft. 4-in., 12,979 ft. 6-in. and 18,978 ft. 8-in. Cl. B. c. i. mains, fittings, etc., at $64,294; also 14,390 ft. 6-in. and 12,490 ft. 8-in. vitr. sewer pipe, at $16,560.

Tex., Rule—Pittsburgh-Des Moines Steel Co., Sumpter Bldg., Dallas, awarded contract for 50,000 gal. steel tank and tower, pump house and machinery, 33 fire hydrants, miscel. valves, 34,800 ft. 2-8 in. cast iron pipe, at $50,000.

Wis., West Allis—Ribbens Bros., Mayville, awarded contract for cast iron mains in 26 streets, at total cost of $76,000.

Prospective Work

ROADS AND STREETS

Cal., Santa Barbara—City Engr., Geo. D. Morrison, estimates paving to be done in this City during 1923, at betw. $800,000 and $1,000,000. Petitions in file engineer's office total about this amount.

Ct., Hardford—City considering plans to cover Park River with rein. conc. slab to be used for parking space. Est. cost, $180,000. R. N. Clark, City, Engr.

Fla., Punta Gorda—Charlotte County contemplates constructing sec. of State Rd. No. 5 thru County. $200,000 bonds available.

Fla., St. Petersburg—Pinellas County plans impvt. of 7 roads. $2,567,000 bonds voted; will also improve bridges; $266,000 bonds voted. C. E. Burleson, Co. Engr.

Ga., Augusta—City (Julian M. Smith, Mayor) contemplates expending $350,000 to $400,000 for paving of certain streets; also resurfacing following conc. and brick streets: Reynolds, 9th, 13th, Monte Sano, etc.

Ky., Frankfort—State Highway Comn.—Frankfort —will improve 3 roads as follows: Resurface 9 miles Bardstown road—Springfield to Nelson Co. line, $42,000; State and Washington Co. each to pay half; gravel 10 miles Ohio River road in Hancock County—Indian Lake to Lewisport—$150,000, Commission to pay one-fourth; resurface 6 miles Richmond Pike in Garrard Co. from point 5 miles from Lancaster to Madison Co. line thru Paint Lick, State and County each to pay one-half. Joe S. Boggs, State Hwy. Engr.

La., Bastrop—Morehouse Parish Police Jury plans to expend $1,100,000 to build 150 miles of road in Parish.

Md., Baltimore—State Rds. Comn., will let contract in July or August for 8 miles additional of Robert Grain Hwy. Jno. N. Mackall, Chmn. of Comn., 601 Garrett Bldg., Baltimore.

Mass, Medford—$250,000 voted for street impvts., and $15,000 for new sewers. R. E. Coolidge, Mayor. Engineer not selected.

Mex., Mexico City—Dept. of Communication and Public Wks., has granted former Senator Gen. Guillermo, Laveaga, concession for constr. of 2 great national highways from Nogales to the Guatamalan border in State of Chiapas and from Mexico City to Laredo or Matamoras. Plan calls for constr. of modern hotels at scenic points along the hwys. Reported that approx. $50,000,000 North American capital is available for the project.

Mich., Detroit—During summer City will expend approx. $4,715,000 on new street pavement and about $2,700,000 on resurfacing old pavements. Jas. A. Martin, Commr. Pub. Wks. Contracts have already been awarded for laying new paving on 46 sts., totaling 15.31 miles at cost of $1,675,000. Commr. estimates that new pavements will be laid in 120 streets during present season. Wk. will cost $4,715,000 and add 45.31 miles to pavement in City. Resurfacing program calls for new pavement on 28 streets, including a number of very important streets. Wash. Blvd., will be widened by cutting down parkway and will have 2 roadways each 43 ft. wide bet. Mich. Ave. and Park Pl. This work will cost $50,000. Gratiot Ave. will be widened and resurfaced between Mt. Elliott and Holcomb Aves., at cost of $225,000.

Nev., Carson City—Secy. of Agriculture has approved project statements on 2 Nevada projects. 1st includes sect. of Rte. 6, Clark Co. bet. Las Vegas and Apex. Est. cost $73,645, Fed. Aid. $64,233; 2nd, Rte. 1, Washoe Co.—Derby to Wadsworth—$157,443; F. A. $137,321.

N. Y., Binghamton—Bd. Pub. Wks. and W. E. Weller, City Engr., are preparing plans for 15,500 sq. yds. of paving on Court Street. Est. cost, $100,000. Granite block will be used.

N. C., Greensboro—City plans streets impvts. Will issue $1,000,000 bonds; also make water works extensions. Will issue $300,000 bonds. B. T. Ward, City Clk.

Okla., Bartlesville—State Hwy. Dept., Okla. City, Okla., plans 40 miles conc. road running no. and so. thru Washington Co. $700,000 available.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Okla., Tulsa—City plans to expend about $145,530 for paving in 13 districts including 9th, Davenport, Independence, Easton Sts., Maybelle, Yukon, St. Louis, Quanah Aves., 13th Pl., Admiral Blvd., etc.

Pa., Lewistown—Will receive bids about July 1st for paving 1 mile Walnut Street; brick and concrete, 20 ft. Est. cost, $40,000. B. H. Craig, Paxtang, Harrisburg, Engr.

S. C., Greenville—City contemplates converting 3 miles Augusta road into 60 ft. boulevard from end of concrete pavement to Lewis home.

Tenn., Dandridge—Jefferson County Court has apportioned $182,000 for 2 roads as follows: $90,000 to complete Straw Plans—Jefferson City rd. to Tanblen County line; $92,000 for Straw Plains-Dandridge and Newport road via Piedmont.

Tenn., Nashville—State Hwy. Dept., Nashville, contemplates bldg. 6 roads as follows: Knox Co., 16 miles rd. from Knoxville to Maryville, Blount Co.; 12 mi. rd. from Knoxville to Jefferson Co. line thru Mascot; Dixie Projs. include 8 mi. from Knox Co. line to Clinton, Anderson Co., and 8 miles from Knox Co. to Lenoir City, London Co.; also considering constr. of 12 miles thru Jefferson Co. from Knox Co. line to Hamblen Co. line; also 10-mile link in Hamblen-Grainger Cos. to Tate Sprgs.

Tex., Barstow—Ward Co. plans to surface and construct rein. concrete and steel bridges and culverts on 17 mi. Bankhead Hwy. S. H. No. 1, bet. Monahans and Reeves Co. line; 5-in. sledged stone base surf.; 4-in gravel top; $135,000. R. E. Booker, Co. Engr.

Tex., Corpus Christi—U. S. Dist. Engr., Fort Worth, has approved plans for bldg. Robstown-Bishop section of S. H. No. 12; 18-ft. gravel base, 1-in. bitum. topping; Nueces County, FAP 342. Est. cost $213,801; Fed. Aid, $22,000. Calvin E. Cook, Co. Engr.

Tex., Liberty—Chf. Engr. U. S. Bureau of Pub. Rds. Washington, D. C., has approved plans to grade and construct bridge on 34.54 miles S. H. No. 3 Liberty Co. FAP 352. Est. cost, $459,156; Fed. Aid, $100,000. C. R. Wilson, Co. Judge.

Tex., Uvalde—Chf. Engr. U. S. Bureau of Public Rds., Washington, D. C., has approved plans for 14.1 miles 18-ft. gravel bitum. surfacing on S. H. No. 3; Uvalde Co. FAP 289. Est. cost, $137,330. H. C. King, Co. Judge.

SEWERAGE AND SEWAGE TREATMENT

Ala., Dothan—City sold $121,000 bonds for san. sewers in eastern section of Town; also storm sewers in business section.

Ont., Brantford—About 1,500 lin. ft. 12-in. glazed tile sewer pipe will be purchased by City for constr. of storm sewers on Clarence, Elgin, Murray, Grey and Chatham Sts. S. F. Leonards, Clk.

Cal., Colusa—Plans being drawn for completion of outfall sewer. It will be of 16-in. concrete. About 1 mile will be laid.

Cal., Irvington—Irvington San. Dist., had plans prepared for san. severage system; $75,000 bonds voted. C. A. Posey, Court House, Oakland, Engr.

Cal., Long Beach—City Engr. A. L. Ferver has completed plans for constr. of 24-in. sewer in Broadway bet. alley east of American Ave. and Ocean Park Ave. to carry overload in business section. Est. cost, $30,000. Plans presented to Council shortly.

Cal., Niles—Niles San. Dist. has had plans prepared for sewerage system. $65,000 bonds voted. G. A. Posey, Ct. House, Oakland, Engr.

Cal., Santa Rosa—Estimates being made for improving sewage disp. plant, including Imhoff tank, trickling filter plant, etc. Cost to exceed $150,000. C. E. Smith, 716 Santa Barbara Rd., Berkeley, Cons. Engrs.

Conn., Hartford—City contemplates construction of small bldg. to contain 2 centrif. pumps for pumping sewage out of Colt Meadows. Est. cost, $25,000. Also considering laying 7,000 lin. ft. 18-24 in. vit. clay and 1,000 lin. ft. 48-in. segmental blk. sewer in So. Marshall, Case, Ward and Palm Sts. Est. cost, $80,000. R. N. Clark, City Engr.

Ia., Cedar Rapids—City considering installing sewage purification plant. Est. cost, $100,000. Engineer not yet selected. L. J. Storey, City Clk.

Ia., Des Moines—Resolution passed for SW sewer system. Will hold hearing June 4. 10 to 48-in. v. c. pipe, brk. manholes, cast iron manhole covers. Est. cost, $590,000. Consult. Engr., J. N. Tippee; A. E. McGlothlen, City Clk.

Ia., Odebolt—Plans being made for sewerage system and disposal plant here. Est. cost, $30,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Engrs.

Ill., Rockford—Plans being made for sewers in 18th St. Dist., to cost $60,700. B. C. Harvey, City Engr.

Kans., Burr Oak—Plans being made for sewerage system here. Est. cost, $40,000. C. A. Haskins, 517 Finance Bldg., Kans. City, Mo., Engr.

Kans., Lyons—Plans being made for completion of sewerage system. Est. cost, $90,000. C. A. Haskins, 517 Finance Bldg., Knas. City, Mo., Engr.

Kans., Sterling—City has had plans prepared for san. sewerage system. Est. cost, $40,000. Ruckel Engr. Co., Interurban Bldg., Hutchinson, Engr.s

Mex., Hermosillo—Gov. A. de la Huerta, as Finance Minister, has signed contract with municipal government here covering provision of funds for constr of new sewer and water systems; also street paving for Hermosillo. Total cost about $461,078.98.

Mich., Ferndale—City considering bond issue in sum $350,000 to pay share of extending sewer in Campbell Ave. from 8th Mile Rd. to 13th Mile Rd., draining town of Ferndale, Pleasant Ridge Village, City of Royal Oak and Royal Oak Twp.; concrete or brick 4-10 ft. diam., also sewage treatment plant.

Miss., Greenwood—City plans to extend storm and san. sewer sys. Est. cost, $38,500. W. S. Hawkins, Engr.

Mo., Bolivar—Prelim. surveys made for san. sewerage system. Est. cost, $100,000. A. T. Archer & Co., 609 New England Bank Bldg., Kans. Cit., Engrs.

Mo., Silkeston—Election may be called to vote on issuance of $55,000 bonds; funds to be used for several miles 16-in. vit. trunk sewers and Imhoff settling tank. If bond issue passes $60,000 worth of lat. sewers will be installed (to be paid for by special assessments). W. A. Fuller Co., 1917 Ry. Exch., St. Louis, Cons. Engrs.

Mo., Trenton—City will receive bids to construct sewers in Dist. 25; rein. conc. Est. cost, about $40,000.

Neb., Burwell—Plans prepared for san. sewerage system, $40,000. Bruce & Grupe, 408 Finance Bldg., Omaha, Engrs. Also preparing plans for san. sewerage sys. to cost $35,000 for Elm Creek, Nebraska. Plans prepared for san. sewerage sys., in Plainview, Neb. Est. cost, $135,000; also for san. sewerage system in Syracuse, Nebraska, at cost of $135,000.

Neb., Omaha—City will soon ask bids for sewer on 16th St.—Grace to 9th Sts.; Grace—11th to Locust St. Est. cost about $300,000. Claude F. Bossie, City Clerk.

N. D., Williston—Will soon call for bids on sewer mains in 50 blocks here. Plan to construct rein. conc. settling reservoir.

Ohio, Canton—McClaskel & Peese, Cons. Engrs. Renkert Bldg., have been retained by City to prepare plans for enlarging sewage disposal plant. Est. cost, $500,000. W. E. Sarver, City Hall, Engr.

Ohio, Cincinnati—City contemplates constr. of Mill Creek intercepting sewer, Cont. 8, Part B, Linden Street, to Hartwell disposal plant, 850 ft. 54-in. concrete pipe. Est. cost, $32,200. F. Krug, City Hall, Engr.

Ohio, New Philadelphia—Plans prepared for reconstructing san. sewers in Public Square on High St.; also in Broadway, South Side, 9th, 10th, Front, College and Hance Sts. Est. cost, $100,000. R. Arnold, City Hall, Engr.

Ohio, Port Clinton—Ottawa County making prelim. surveys for sewage disposal plant and water works system. Est. cost $300,000. R. E. Garvin, Davis & Farley Bldg., Cleveland, Engr.

Okla., Erick—Plans being prepared for sewerage system and disposal plant. Est. cost, $60,000. C. T. Derr, 200 E. Main St., Okla. City, Engr.

Okla., Okla. City—Election will be called on vote on $1,500,000 bonds for constr. of outfall sewerage system and disposal plant. Prelim. plans being prepared. B. M. Hart, City Engr.

Ore., Albany—Council planning storm sewer to

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
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American District Steam Co.

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Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
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Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
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William F. Morse.

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The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
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Mixers—Mortar.
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Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

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Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

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Medal Paving Brick Co.
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Murphysboro Paving Brick Co.
National Paving Brick Mfrs Assn.
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Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

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The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

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Austin-Western Road Machinery Co.
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Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

serve 436 acres in S. W. sect of City. Est. cost, $53,650. Action taken following submission of prospectus of project by R. E. Koon, of Stevens & Koon, Engrs., Portland.

Pa., Erie—City considering constr. of 11 sewer drains at est. cost of $56,090. F. G. Lynch, City Engr.

Pa., Sharon—City will receive bids in near future for 2 sewage disposal plants to be built in 2 units. Est. cost, $200,000. L. E. Burnside, City Engr.

Tenn., Milan—City considering completion of sewerage system. $100,000 bonds voted. H. P. Webb, Mayor.

Tex., Dallas—Making plans for sewer mains and 12 new tanks in disposal plant in So. Dallas. Est. cost, $500,000. E. A. Kingsley, City Engr.

Tex., Hearne—Plans being made for extension of sewers to cost $60,000. Municipal Engrg. Co., 715 Praetorian Bldg., Dallas, Engrs.

Wis., Madison—City Engr. E. E. Parker, preparing plans for sewage disposal plant. Est. cost, about $150,000. Site purchased; work will begin this summer.

WATER SUPPLY AND PURIFICATION

Ala., Alexander City—Plans being prepared for constr. of water wks. system at cost of $100,000.

Ala., Irondale—Irondale Water Co. has petitioned Ala. Pub. Service Commission for permission to construct and operate water works plant.

Ark., Van Buren—It is proposed to make impvts. to present pumping station on Lee's crk., consisting of intake 700 ft. above pumping sta. installation of 2 sets of motor driven pumps with duplicate units, 500 gal. capy. per min. each; 2 filter units each having capy. of 500,000 gals. per day; concrete reservoir 40 ft. diam. and 20 ft. deep; extend distribution system; install 98 fire hydrants. W. L. Winters, Civil Engr., Ft. Smith.

Ariz., Tucson—City Council will be asked by joint committee in charge of water system enlargement to retain expert engineer to make survey of City system. J. E. White, head of Comm.

Cal., Belvedere—Belvedere Water Corporation, which has been organized to take over prop. and service of Belvedere Water Co. serving Belvedere dist. east of Los Angeles City limits, has applied to Railroad Comn., for authority to transfer property and to issue $300,000 1st mortgage bonds to pay for same, make necessary additions, impvts. and betterments to system.

Cal., Long Beach—Council developing plans for expendt. of $2,500,000 for new water sys., involving constr. of new reservoir, increasing storage capy. from 5,000,000 to 40,000,000 gals. and laying new water mains. A number of wells will also be drilled. It is reported bond issue will not be necessary.

Cal., Los Angeles—Mexican Petroleum Co., granted franchise to construct 28 miles pipe line from Santa Fe Springs to coast. Company considering bldg. refineries, storage farms, pumping stations, etc., totaling about 15,000,000. Pipe line referred to will cost about $150,000.

Cal., San Bernardino—Council discussing bond election to vote on issue of $80,000 for purpose of providing funds to bring Devil Canyon waters to City. This wk. will involve drilling 2 wells and necessary reservoirs. F. C. Finkle, Hydr. Engr.; C. E. Johnson, City Engr.

Cal., San Diego—City has retained J. R. Freeman, Engr., 815 Grosvenor Bldg., Providence, R. I., to investigate and make recommendations relative to construction of dam on San Diego river for municipal water impounding system.

Cal., Santa Barbara—Montecito Water Board has received approval of proceedings for $800,000 bond issue from O'Melveny, Milliken, Tuller & McNeil. Leeds & Barnard, Central Bldg., Los Angeles, engaged as consulting engineers on project and are now at work on detailed plans for water tunnel to be built in Toro Canyon.

Cal., Santa Barbara—Southern Counties Gas Co. has obtained permission from railroad commission to build pipe line from Ventura oil fields to Santa Barbara. Work will involve compressor station in oil field and 6-in. transmission line to City. Est. cost, $277,000.

Cal., Upland—Geo. S. Hinckley has recommended that Council call election to vote on $225,000 bond issue for municipal water works system. Present system would be purchased and enlarged, while additional water-bearing land would be secured.

Ont., Hamilton—Constr. of new filter basin and chlorination plant is planned. Est. cost, $50,000.

Ont., Lansing—No. York Twp., plans laying 30,000 ft. cast iron mains as follows: 8-in. in Drury and Brooke Sts.; 10-in. in Donlands Ave., Yonge St. from Humberstone to Old Yonge Sts., Old Yonge and Donino Sts.,and Yonge St—Huberstone to Drury Sts.; 12-in. in Humberstone: $114,732. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Que., Levis—City will call for bids in near future for filtration plant. Est. cost, $100,000. Lionel Lemieux, City Clk.

Ont., Oshawa—Water works extens., being considered here, will include purchase of 300 water meters and 20 hydrants. W. C. Smith, Town Hall, Engr.

La., W. Monroe—City voted $165,000 bonds for water and sewer and other impvts. R. S. Reynolds, City Engr.

Md., Linthicum Hts.—Public Service Comn., has authorized Anne Arundel San. Comn., Annapolis, Md., to issue $66,000 bonds for improved water supply and sewer service for Linthicum Heights and Glenburnie. Est. cost, $26,000 for Glenburnie and $40,000 for Linthicum Heights.

N. Y., Ontario—City contemplates constructing new water supply system. Est. cost, $85,000.

N. C., Henderson—Henderson Water Co.—J. R. Teague, Secy.—will increase capital from $100,000 to $300,000. Will extend and improve plant.

N. C., Southern Pines—City has plans for constr. of water works sys. Will impound water from stream about 2 miles from Southern Pines; construct 1,000,000 gal. filter plant and pipe lines. Gilbert C. White Co., Cons. Engrs., Durham, N. C.

Ohio, Painesville—City considering constr. of water supply system of tanks or reservoir. Est. cost, $250,000. Hadlow, Hick & Co., Finance Bldg., Cleveland, Cons. Engrs.

Okla., McAlester—City voted $375,000 bonds for water extensions.

Okla., Okmulgee—City has retained Burns & McDonnell, Cons. Engrs., 402 Interstate Bldg., Kansas City, Mo., to make surveys and investigations for storage reservoir and dam on Deep Fork Creek, creating lake approx. 7 miles in length covering 25,000 acres, etc. Bond election in Sept., 2,000,000.

Ore., Portland—City plans new Bull Run gravel pipe line system, 10 miles 60 in. and 15 miles 52 in. vert. lock joint, or electric weld pipe, 3 miles clearing, one 300 ft. pipe span and one 250 ft. comb. highway and pipe span; $3,500,000. F. W. Randlett, City Hall, Engr.

Pa., Philadelphia—Council will carry plans thru rapidly for construction of reservoir of 100,000,000 gals. daily capy. at Greenlane. Unanimous approval of proj. expressed.

S. C., Chesnee—City considering voting of $80,000 bonds for water works system.

Tenn., Chattanooga—City Water Company will expend approx. $150,000 on impvts. to central pumping plant at Citico, etc. Plans include installation of two 350 h. p. boilers equipped with automatic stokers; one 10,000,000 gal. and one 15,000,000 gal. turbine driven symmetrical pump; laying new suction main from clear water basin to pumping station. Will increase capy. of plant from 28,000,000 to 38,000,000 gals. daily. C. F. Porzelius, Mgr.

Tex., Abilene—City Comn. authorized constr. of filtration plant. Est. cost, $40,000.

Tex., Austin—City considering erection of complete water plant consisting of pumping, filtration and softening units with capy. of 8 million gals. water daily.

Tex., Galveston—City formulating plans for rehabilitation of water works plant at Alta Loma. Plans call for installation of 2 new engines in sep. units with capy. of 200 h. p. and several pumps, capy. not determined. R. P. Williamson, Commr. of Water Works and Sewerage; Wilmer D. Masterson, Supt. of Water Works & Electricity; $125,000 bonds voted.

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Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

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Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

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Kolesch & Co.

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Coldwell-Wilcox Co.

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Austin Machinery Corporation.
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Phoenix Mfg. Co.

Special Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

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Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Surface Heaters
Chausse Oil Burner Co.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

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Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

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Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
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Warren Bros. Co.

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National Water Main Cleaning Co.

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U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
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Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
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The Refinite Co.

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Austin-Western Road Machinery Co.

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Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

INDEX TO ADVERTISEMENTS

Alvord, Burdick & Howson, Chicago, Ill. 14
American Steel & Wire Co., Chicago, Ill. 18
American Telephone & Telegraph Co., New York, N. Y. 6
American District Steam Co., North Tonawanda, N. Y. 20
Artingstall, Wm., Chicago, Ill. 14
Austin-Western Road Machinery Co., Chicago, Ill. 18
Austin Machinery Corporation, Toledo, Ohio ..... Back Cover

Barrett Co., The, New York, N. Y. 23
Brossman, Chas., Indianapolis, Ind. 14
Buffalo-Springfield Roller Co., Springfield, O. 12
Burd & Giffels, Grand Rapids, Mich. 14
Buyers' Guide 29, 31, 33

Cannelton Sewer Pipe Co., Cannelton, Ind. 15
Carey Co., The Philip, Cincinnati, Ohio 7
Chausse Oil Burner Co., Detroit, Mich. 12
Chicago Paving Laboratory, Chicago, Ill. 14
City Wastes Disposal Co., New York, N. Y. 14
Coldwell-Wilcox Co., Newburgh, N. Y. 16
Cummer & Son Co., F. D., Cleveland, Ohio 19

Dee Clay Mfg. Co., W. E., Chicago, Ill. 19
Dee, Wm. E., Chicago, Ill. 15
De Laval Steam Turbine Co., Trenton, N. J. .....
Dow & Smith, New York, N. Y. 14
Druar & Milinowski, St. Paul, Minn. 14
DuPont DeNemours & Co., E. I., Wilmington, Del. 10

Engineers and Contractors 14, 15
Evinrude Motor Co., Milwaukee, Wis. ..... Inside Front Cover

Fargo Engineering Co., Jackson, Mich. 14
Flood, Walter H., Chicago, Ill. 14

Harris Air Pump Co., Indianapolis, Ind. .....
Holt Mfg. Co., Inc., Peoria, Ill. 9
Howard, J. W., New York, N. Y. 14
Hunt, Robert W. & Co., Chicago, Ill. 14

Jones, Sam L., Cincinnati, Ohio 14
Jordan & Steel Mfg. Co., Inc., Charlotte, Mich. .....

Kalamazoo Foundry and Machine Co., Kalamazoo, Mich. 25
Kentucky Rock Asphalt Co., Louisville, Ky. 13
Keystone Driller Co., Beaver Falls, Pa. 16
Kirchoffer, W. G., Madison, Wis. 14
Kissel Motor Car Co., Hartford, Wis. .....
Koehring Co., Milwaukee, Wis. 8

Littleford Bros., Cincinnati, Ohio 19
Lufkin Rule Co., Saginaw, Mich. 19
Luten, Daniel B., Indianapolis, Ind. 15

Murphysboro Paving Brick Co., Murphysboro, Ill. 25

National Paving Brick Mfrs. Ass'n, Cleveland, Ohio 5

Olsen Testing Machine Co., Philadelphia, Pa. 15

Pawling & Harnischfeger Co., Milwaukee, Wis. .....
Pennsylvania Salt Mfg. Co., Philadelphia, Pa. 16
Pierce-Arrow Motor Car Co., Buffalo, N. Y. .....
Pioneer Asphalt Co., Lawrenceville, Ill. 18
Portland Cement Association, Chicago, Ill. 3
Potter, Alexander, New York, N. Y. 15

Rosing, Inc., Astrid S., Chicago, Ill. 15

Sauerman Bros., Chicago, Ill. 15
Smith Co., The T. L., Milwaukee, Wis. .....
Standard Oil Co. (Indiana), Chicago, Ill. ..... Inside Back Cover
Stewart, W. H., St. Louis, Mo. 25
Strickler, W. W. & Bros., Columbus, Ohio 16
Sullivan, Long & Hagerty, Bessemer, Ala. 15

Texas Co., Asphalt Sales Dept., New York, N. Y. .....
Trucson Steel Co., Youngstown, Ohio .....

United States Asphalt Refining Co., New York, N. Y. .....
United States Cast Iron Pipe & Foundry Co., Burlington, N. J. 16

Van Trump, Isaac, Chicago, Ill. 15

Warren Brothers Co., Boston, Mass. 1
Wells, James P., Rochester, N. Y. 15
Westinghouse Electric & Manufacturing Co., South Bend, Ind. 11
Wilson Engineering Corp., Hanover, Mass. 15

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—Road Rollers
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—Saw Rigs
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—Steam Shovels
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—Stone Screens
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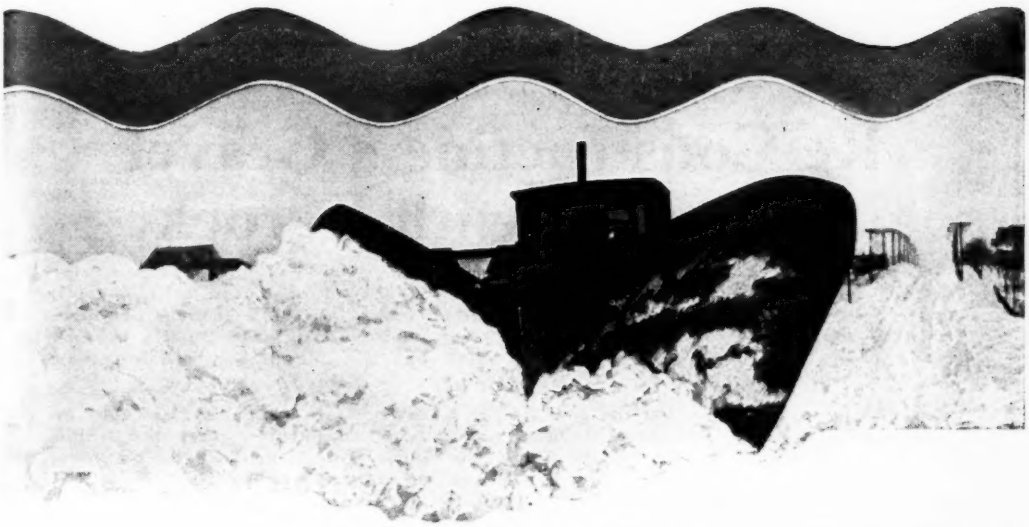

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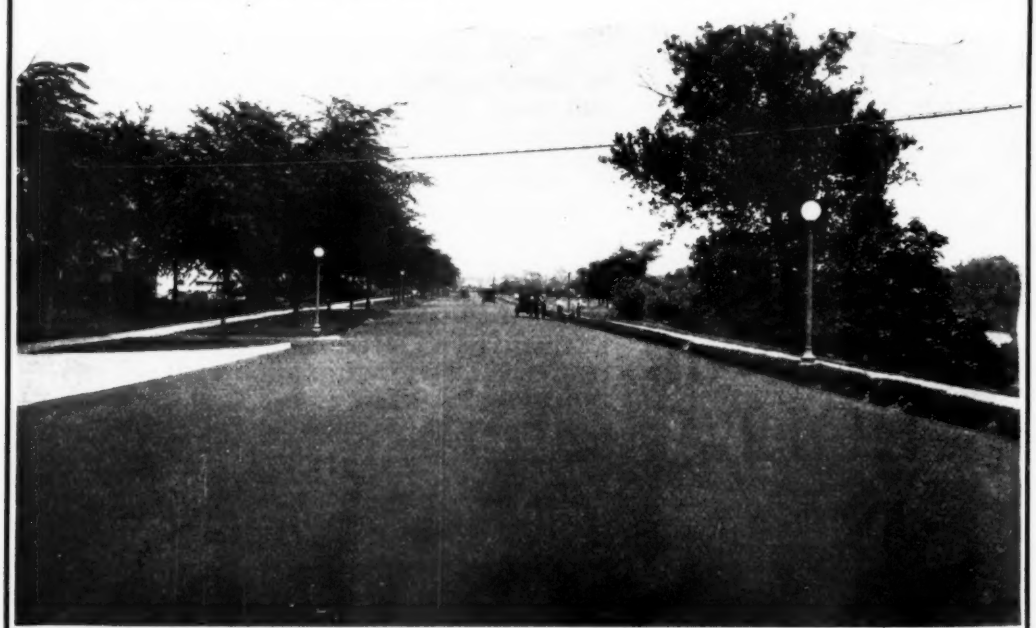

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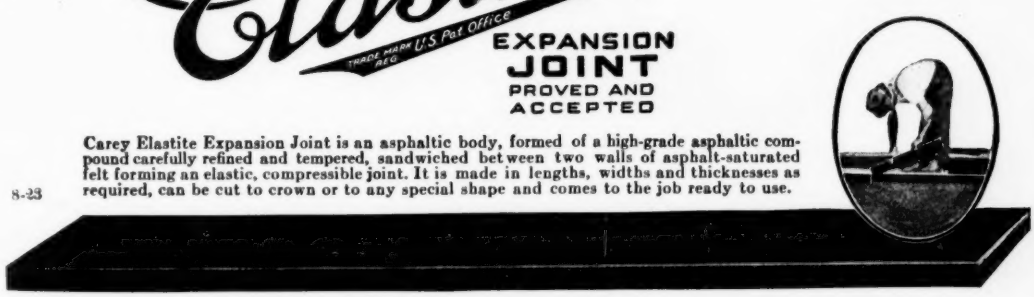

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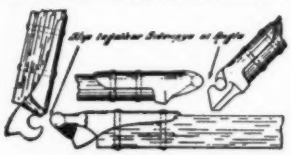

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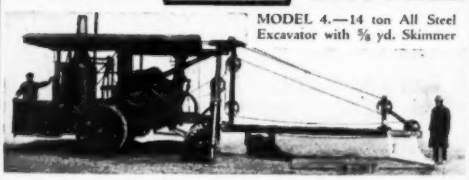

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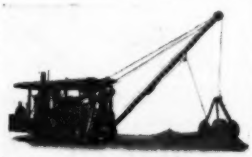

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